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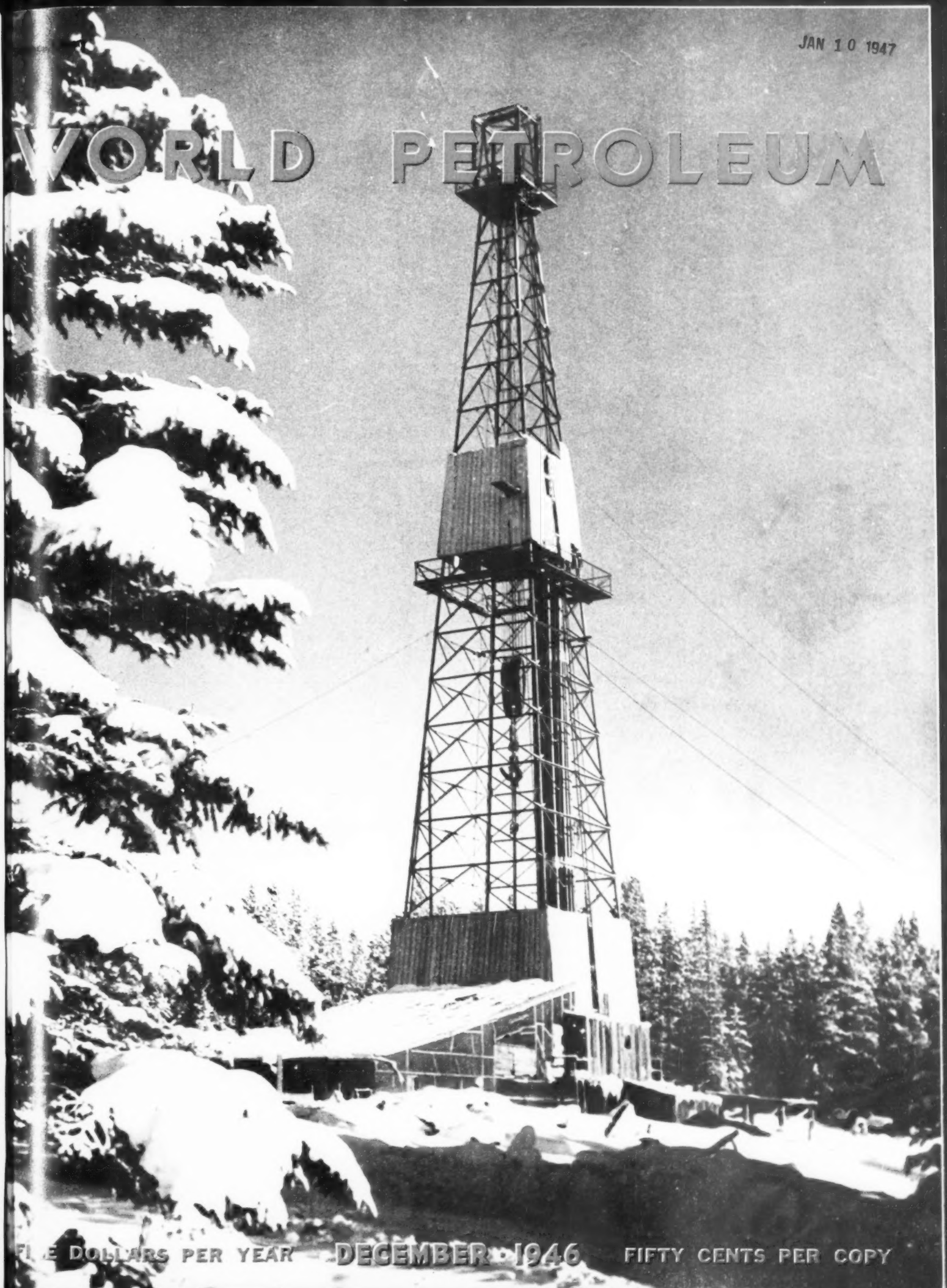
WORLD PETROLEUM



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WORLD PETROLEUM

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CONTENTS

VOLUME 17 DECEMBER, 1946 NUMBER 13

Oil Industry and the Threat of Depression 39

Expansion of Trinidad's Oil Industry 40

Warren's Holliday Gasoline Plant 43

Ethyl Corporation's Research Program 46

ASTM Undertakes Diesel Fuel Study 50

Domestic Fuel and Burner Groups Plan for Demand Increase 52

Potential Oil Resources of South America 54

J. Edgar Pew—1870-1946 58

Flowing Production in Secondary Recovery 59

Katy Field 64

Oil Company Changes 68

Oil Issues Before the New Congress 70

International Notes 72

Mr. Hoge goes to TEXAS

FRIDAY: Houdry Laboratories receive a long distance call from a Texas refinery, requesting assistance in the operation of a TCC unit. Wesley Hoge, able Houdry engineer, leaves by train the next day. (He would have flown but all planes were grounded.)

TUESDAY A. M.: Mr. Hoge arrives at the refinery, confers with Houdry's Texas representative and refinery management; then inspects unit.

THURSDAY NOON: At Hoge's suggestion, unit is shut down to permit examination of the reactor.

THURSDAY MIDNIGHT: Twelve hours after shut-down began, inspection of the reactor has been completed, mechanical adjustments made per Hoge's recommendations, and unit is ready to resume operation. Pretty good time, even for a TCC!

FRIDAY: Unit is operating at rated capacity and producing 1,000 B/D *more gasoline* than prior to shut-down. Mr. Hoge takes a bow but not his departure—he stays right there to make sure the operation stays right.

TWO WEEKS LATER: Even Mr. Hoge is satisfied and leaves for home. Refinery executives write nice letters to Houdry. It's really nothing extraordinary, just typical of the kind of service Houdry gives its licensees.

Houdry service begins with the blueprints and never ends!

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EDITORIAL

OIL INDUSTRY AND THE THREAT OF DEPRESSION

Wherever business men gather, in trade assemblies or private groups, discussion inevitably turns to the incongruous situation that now exists, with costs rising, profits disappearing and signs of business recession clearly in evidence; this in face of a vast unsatisfied demand for consumer goods and durable commodities. While the oil industry has had to contend since the war with increased operating expense and shortages of materials for needed equipment it has been beset by fewer difficulties than many other businesses and the demand for its products has been unexpectedly high during the year now drawing to its close. Yet the oil industry is basically a purveyor of energy in the form of liquid fuels on which the entire national economy increasingly depends. Consequently the trend of industrial activity, the rise or fall in the level of prosperity, cannot fail to find some reflection in the pace of its activities and the demand for its products.

In the matter of production, in meeting the accumulated demand of domestic and foreign purchasers for manufactured products, the record of 1946 has been doubly disappointing because of the high expectations that had been created by developments immediately following V-J Day, 1945. Instead of the acute deflation and widespread unemployment during a prolonged period of reconversion which had been forecast in official circles and feared by many members of the business community events followed a most encouraging pattern. Within two months succeeding the close of hostilities management carried out a task of preparation for large scale peacetime production no less remarkable than its rapid mobilization to meet military needs at the commencement of the war. Workmen released by the closing of munitions plants and men discharged from the armed forces were promptly absorbed into industry and the number of employed actually increased. Recognizing the need for pay adjustments many employers voluntarily increased wage rates. Everything appeared set for full speed ahead on the industrial front.

Speaking before the American Petroleum Institute last month Alfred P. Sloan, Jr., chairman of the board of General Motors Corporation, pointed out the exact date when the process of retrogression set in. It was at the end of October 1945. At that time the administration in Washington projected a policy declaration that wage increases were imperative and that it was equally necessary to "hold the line" on prices to prevent a rise in the cost of living. To support this proposal it was solemnly stated that wage advances up to 30 percent could be paid by employers out of profits without any rise in the cost of manufactured products. This pronouncement, coming from the highest official quarters, was in effect a broad invitation to organized labor to present new and heavy demands for much higher pay, an invitation of which union leaders promptly took advantage.

In the normal functioning of the economic system wage increases come as a result of increased productivity by workers. It is through this process, largely aided by the development of automatic machinery which has multiplied individual output, that the workers of America have attained the largest incomes and the highest standard of living that prevail in any part of the world. In this instance, however, the change has been followed by an alarming decline in individual output, thus adding still further to the cost of production. In the case of some goods the cumulative effect of these factors has raised the cost of manufacture by as much as 50 percent. At the same time the attempt to hold prices at the levels established when wage costs were under similar control made the production of numerous commodities uneconomic, thereby adding to the shortages that previously existed.

Through the economic unbalance resulting from conferring on favored groups monopolistic advantages in which the majority of productive workers do not share a cycle of spirally ascending costs and prices has been created which, if not otherwise checked, will put many products out of reach of the average purchaser, thus leading to lessened demand, widespread unemployment and a lowering of the general standard of living, a downward swing in which the early recipients of favored treatment must inevitably participate along with those who had no part in its inception.

Fortunately for the oil industry and for the oil equipment industry so closely related to it two factors will operate to lessen the impact of whatever decline in general industrial activity may take place. Oil products have become so essential to the daily life of individual Americans that they will be among the last to be dispensed with. Moreover, the demand for oil products and oil industry equipment from the rest of the world is still rising and must remain active for a long time to come. Vigorous cultivation of the export field may confidently be counted on to offset any temporary recession that may take place in the domestic market.

Refinery of Trinidad Leaseholds, Ltd., at Pointe-a-Pierre

WAR BROUGHT EXPANSION TO TRINIDAD'S O

By M. V. Yale

ALTHOUGH the operations of the Trinidad oil industry were kept under a veil of secrecy during the war for reasons of military security, its great service to the Allied war effort is well known in official circles and to oil men generally. Its strategic location close to the main highway of plane and ship travel across the Atlantic during the earlier part of the war gave it special importance in the years when the enemy submarine menace was at its height and the island played a large part in fueling the transport equipment of the Allies.

To accomplish the task put before them Trinidad's oil companies worked together as a unit. They drilled shallow wells in known reserves to conserve their steel which was jointly shared. They sent their crude to the island's two refineries operated by Trinidad Leaseholds Ltd. at Pointe-a-Pierre, and by United British oilfields of Trinidad (Shell) at Point Fortin.

To augment the production of urgently needed 100-octane, a new refinery was built at Pointe-a-Pierre. The existing refinery at La Carriere, built from 1917 onward by Trinidad Leaseholds, included two Dubbs cracking plants erected in 1927, two cracking units added in the early thirties, and a fifth in 1937. In 1938 a plant was installed for making iso-octane. The new war-time refinery was built for the purpose of manufacturing 100-octane gasoline on the far larger scale which the war demanded. United British Oilfields of Trinidad, Ltd. also constructed another topping unit in its refinery to handle the extra crude from increased wartime production.

"Project 1234" as the Leaseholds refinery was known, was successfully cloaked in secrecy from the time construction was begun in September 1940, to the war's end. It was a project of the British government under the Ministry of Aircraft Production, and was built in collaboration was Trinidad Leaseholds, Ltd.

Many individual organizations were engaged on the design and fabrication of the plant, the work being coordinated by special committees set up in London and New York in collaboration with the Universal Oil Products Company. Since time was the vital factor, Arthur G. McKee and Company of Cleveland, who constructed the refinery, flew to Trinidad hundreds of highly skilled craftsmen of every kind.

Although the location of Trinidad away from the main theatre of war was a distinct advantage, the materials for the new refinery which had to be transported by sea, were exposed to the menace of submarine warfare but this danger was circumvented. Time was saved by obtaining units which had been fabricated for the use of other refineries.

Ground was first broken for the foundations of the new refinery in September 1940, and in spite of the fact that much of the construction had to be done during the torrential rains of the wet season, the teamwork was so effective, that one of the main refinery components, the naphtha reforming unit, began operation in August 1941, just eleven months later.

The first main process units of the new refinery were: a naphtha reforming unit; a normal butane

these refineries the output of 100-octane progressed to higher levels during the war years. Following the cessation of hostilities, this refinery was acquired by Trinidad Leaseholds from the British government, and converted to peacetime operation.

Trinidad's other refinery which supplied much of the blending stocks for Project 1234, oil for fueling allied ships, and asphalt for the runways and roads of United States air bases, is the plant of United British Oilfields of Trinidad, located at Point Fortin.

Starting from a single oil well and a few buildings some forty years ago the company's camp at Point Fortin now includes an extensive producing field, refinery, loading facilities, office, shops, and attractive staff quarters. Present payroll numbers about 2,700.

It was some years after its early and modest beginning that UBOT became one of the Shell group of companies and has since achieved several outstanding accomplishments.

The company's two producing fields are Point Fortin, covering from 10 to 15 square miles, and Penal field, about five square miles. The former is carved out of thick jungle with miles of intersecting paved roads. These have been surfaced with pitch sand from the outcroppings at several quarries as a convenient method of providing smooth and well-built field roads. For main roads regular bitumen emulsion methods are used.

Since Penal field is lagoon land, it is very swampy. The East Indians who are the island's main agricultural workers and, incidentally, make up one-third of Trinidad's population, grow their rice right up to the derrick legs. Accordingly, great care must be taken not to pollute the rice fields. The company has solved this problem by building a four-foot retaining wall around each location, then during drilling operations all waste mud is picked up from the cellar by a mud pump and pumped to a waste pit.

UBOT is now running five drilling strings, four steam and one diesel with a diesel repair string. During the war, in close collaboration with the controlling authorities and with PAW in Washington, attention was devoted to exploitation of the company's main reserves rather than to exploration and wildcatting, in order to obtain a maximum of oil with a minimum amount of steel used. Now, however, new structures and new depths are being explored, the latter by means of the company's FC-98 of 11,042 feet, Trinidad's deepest well.

UBOT's refinery contains two topping units with a combined capacity of from 25,000 to 30,000 barrels per day, treating auxiliaries, an asphalt plant and an emulsion plant, drum and tin factory, and an Edeleanu extraction plant for the production of high smoke point kerosene.

One of the topping units, built in 1933, consists of a single stage evaporator and fractionating column. Completed in 1943 was another evapo-

Crude topping plant at United British Oilfields of Trinidad, Ltd., refinery, Point Fortin.

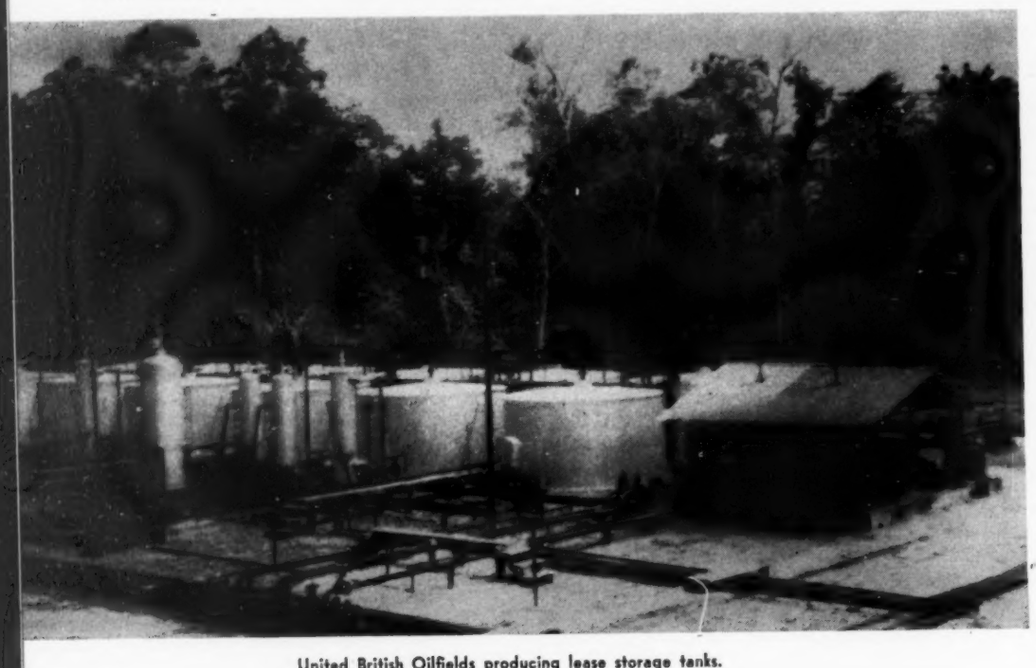
OIL INDUSTRY

isomerization unit; a sulfuric acid alkylation unit, a crude oil topping unit, and a gasoline rerunning unit. These process units required the operation of various auxiliaries among which were plants for the manufacture of sulphuric acid (additional to the sludge recovery plant already in operation) isomerization catalyst and hydrochloric acid.

Main objective from the start was to obtain more and still more butane fractions. As isobutane requirements for alkylation had to be brought into balance by the conversion of normal butane to iso-butane, supplies of normal butane for isomerization were as important as the unsaturated butanes from cracking and reforming. Much was accomplished through the operation of all refineries in the Caribbean area under the Foreign Operations Committee of the Petroleum Administration for War. Not only were additional butanes secured in Trinidad, but more were brought in in admixture with other distillate stocks which themselves were required either for further processing or for inclusion in the final 100-octane blend. Through the cooperation of

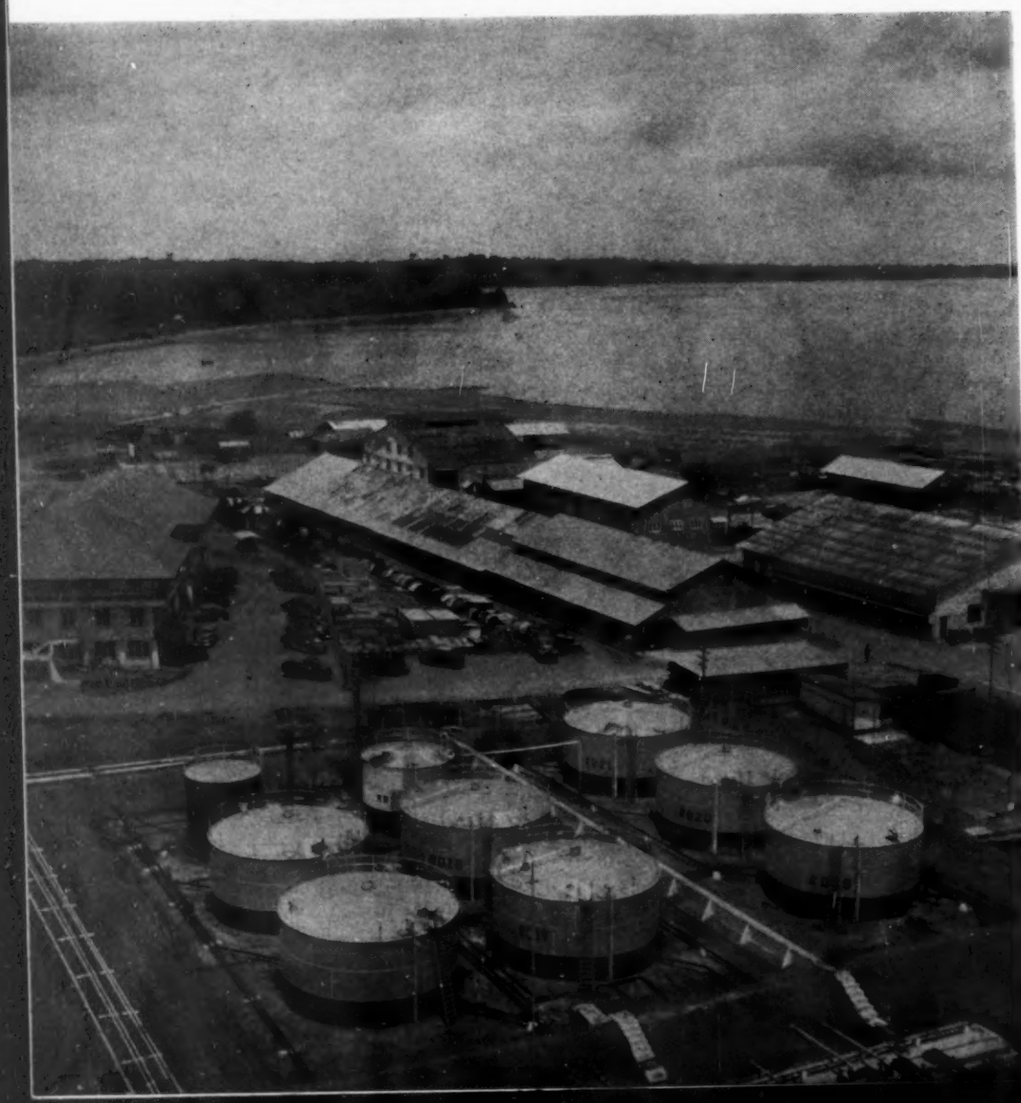
rator for the manufacture of steam refined bitumen. Products from this unit are 12,000 barrels daily of aviation base stock, solvent, diesel, and heavy fuel oils.

The other topping unit, brought on stream in 1940, handled the extra crude from increased wartime production in the field, and consists of a 2-coil McKee furnace reboiling the bottoms of two fractionating columns. This unit has a daily crude capacity of 18,000 barrels per day, producing aviation base naptha, kerosene distillate, gas oil for diesel blending, and straight-run fuel residue which was blended to meet naval requirements. The aviation base stock was pumped by pipe line from Point Fortin to the Trinidad Leaseholds Ltd. refinery at Pointe-a-Pierre for reforming in connection with the government wartime program for 100-octane gasoline.



United British Oilfields producing lease storage tanks.

General offices, storehouses and rundown tanks at Point Fortin plant.



The capacity of the bituminous emulsion plant during the war was increased to 2,400 barrels per day and the bulk of the production went into constructing roads and runways for air bases, including the Churchill-Roosevelt Highway connecting the main airport with Port of Spain, and for Allied bases in the south Caribbean area.

As for marketing, the export trade is handled by Shell Group tankers, loading from UBOT's 8,520-foot jetty, built in 1933 and equipped with an additional loading berth in 1938. Coastal schooners handle a considerable amount of the packed products trade, and supplies also are delivered by small shallow draft tankers. Shell Leaseholds, Ltd., takes care of all local markets.

Major developments in modernizing the Point Fortin camp have taken place within the past ten years. The camp has a modern general hospital and laboratory, library, swimming pool, tennis courts, sports grounds, golf course and club houses. Club and sports have also been inaugurated for the labor force, many of whom live in the model houses inaugurated in 1940. With the company's anti-malarial control program of clearing adjacent jungle and by intensive spraying with Shell Malariol, a product produced in the refinery at Point Fortin and largely developed in the company's laboratories, the incidence of malaria has now dropped to practically nothing.

The company has an interesting apprentice training scheme which is run in collaboration with the colonial government's industrial training program. Boys of from 15 to 16 are recruited for training as apprentice mechanics, welders, draftsmen, fitters, turners, and for other skilled work necessary in the fields and refinery. This year marks the graduation of the first of the apprentices who have successfully completed the five-year course of technical training, given while the boys were employed. Enrollment is increasing each year.

For boys too old for the 5-year apprentice scheme, a trainee scheme is in effect. Here boys over 16 and under 18 are recruited, also chiefly from sons of company employees, to be trained for various jobs such as stores attendants, laboratory assistants and other non-apprenticeable jobs. This training covers a period of approximately two years.

UBOT's general manager is W. M. V. Ash; assistant manager, J. S. Gaynor; refinery manager, J. Grant; chief exploitation engineer, Dr. J. E. Smith; production superintendent, J. G. Ogilvie; materials superintendent, J. T. Gray; and drilling superintendent, L. W. Humphries.

WARREN'S HOLLIDAY GASOLINE PLANT INCORPORATES NEW DESIGN FACTORS

By H. M. Nelly, Jr.*
and
Dr. Thos. E. Sullivan†

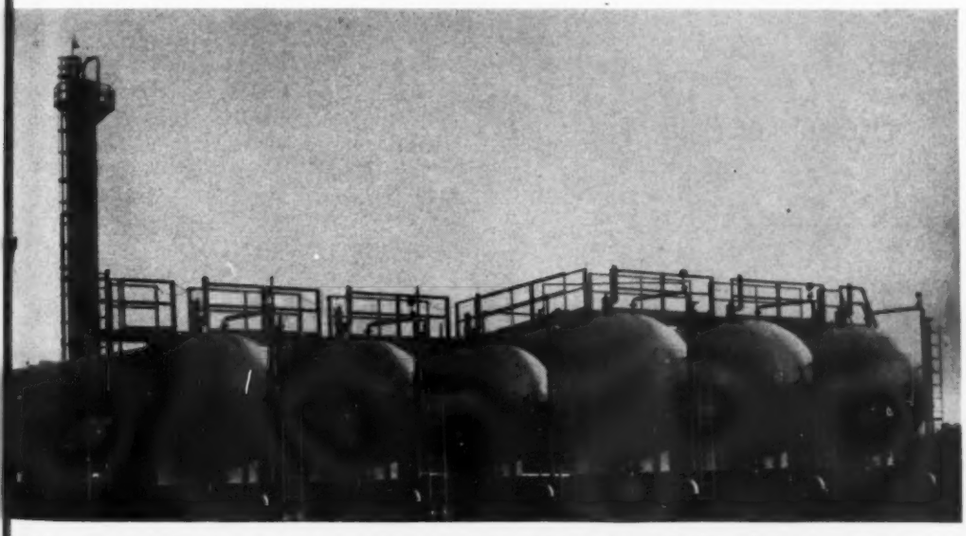
WARREN Petroleum Corporation first entered the liquefied petroleum gas field as a manufacturer and wholesale distributor in 1935. Since that time, they have built up their position in this field to such a point that during the war years the corporation was one of the largest independent suppliers of such material as normal butane, iso-butane, and isopentane, as well as natural gasoline.

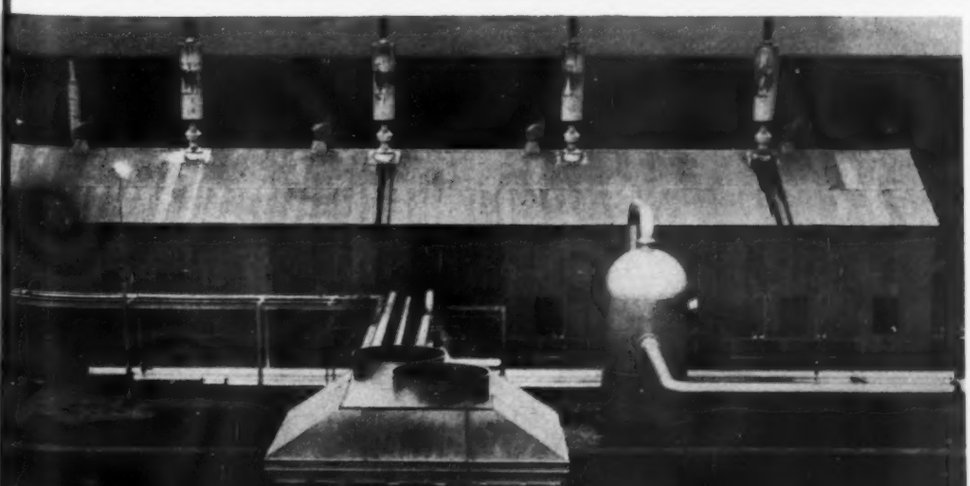
Recognizing the present trend toward increased demands for LPG and natural gasoline of controlled Reid vapor pressure, the corporation decided in 1945 to install a natural gasoline recovery plant in the Hull-Silk Field, near Holliday, Texas, for the production of propane, butanes, and natural gasoline from low pressure field gas. The design and engineering work on this new plant was handled by J. F. Pritchard and Company of Kansas City, in cooperation with Warren's engineering staff. The construction was done by Pritchard.

The design and engineering phase of the project was begun in September, 1945, and the plant was placed "on stream" in July, 1946. Processing capacity of the plant is approximately 15,000,000 standard cubic feet per day.

The Holliday plant is different in three major repects from the conventional modern gasoline plant. First, no steam is used; second, the majority of the cooling is done with air coolers; and third, all recycled gas streams have been eliminated by use of a stripping section in the bottom of the absorber.

Lower photograph shows Alco coolers for compressed wet gas adjacent to compressor room. LPG and natural gasoline storage tanks are shown in the upper picture in front of depropanizer and debutanizer columns.





The elimination of steam, and the use of air coolers, was dictated in part by the limited quantity of water available in this particular locality, and further by the fact that the water which is available has a very high dissolved solids content, making treating necessary and expensive. A small amount of water aftercooling has been provided on the product streams and also at the absorber to increase its efficiency. However, these services are at temperatures below 120°F, making treating of the water unnecessary.

The elimination of all recycled gas streams has the advantage over present day conventional natural gasoline plants, where high butane and propane recovery is required, in that all of the dry gas is eliminated from the plant at top pressure without recompression or handling through the still and fractionating equipment.

A further advantage in not using steam and in eliminating the recycled gas streams is that the plant is greatly simplified, thus bringing about a reduction both in initial capital investment and in operating expense.

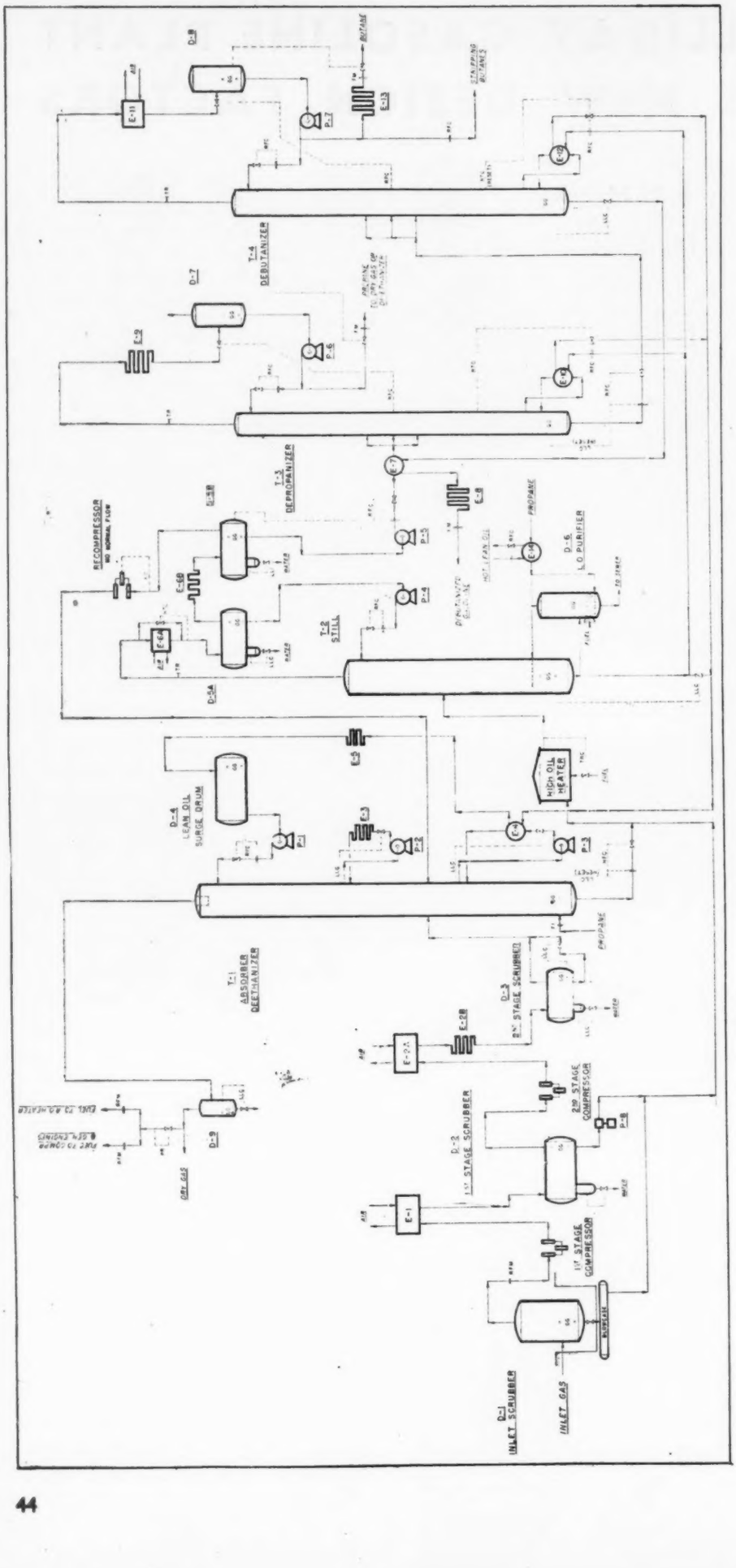
Referring to the flow diagram, the inlet wet gas enters the plant under a slight vacuum and is compressed in two-stages to a pressure of 200 pounds per square inch. Inter-stage and final gas cooling is accomplished with Alco air coolers, except that water cooling is provided at the outlet of the final stage air cooler to lower the temperature of the gas from 120° to 100°F.

The compressed wet gas is discharged into the absorber-deethanizer tower. The top 20 trays in this tower form the absorption section, up through which the wet gas flows and the natural gasoline, butanes, propane and some ethane and methane are absorbed by lean oil which flows down the tower counter-current to the gas. The dry gas, leaving the top of the absorber, flows through a mist extractor to a knock-out drum and is then used as plant fuel or returned to the field. An intercooler has been provided midway in the absorber for removing heat of absorption, thus increasing the overall absorption efficiency.

Substantially 100% of the natural gasoline, 99% of the butanes and approximately 60% of the propanes are recovered in the absorber.

The rich oil, leaving the absorber section of the tower, contains appreciable amounts of methane and ethane which either have to be removed at

* *Manager, Petroleum Division, J. F. Pritchard & Co.*
† *Assistgant Manager, Petroleum Division, J. F. Pritchard & Co.*



Flow diagram of Warren's Holliday gasoline plant.

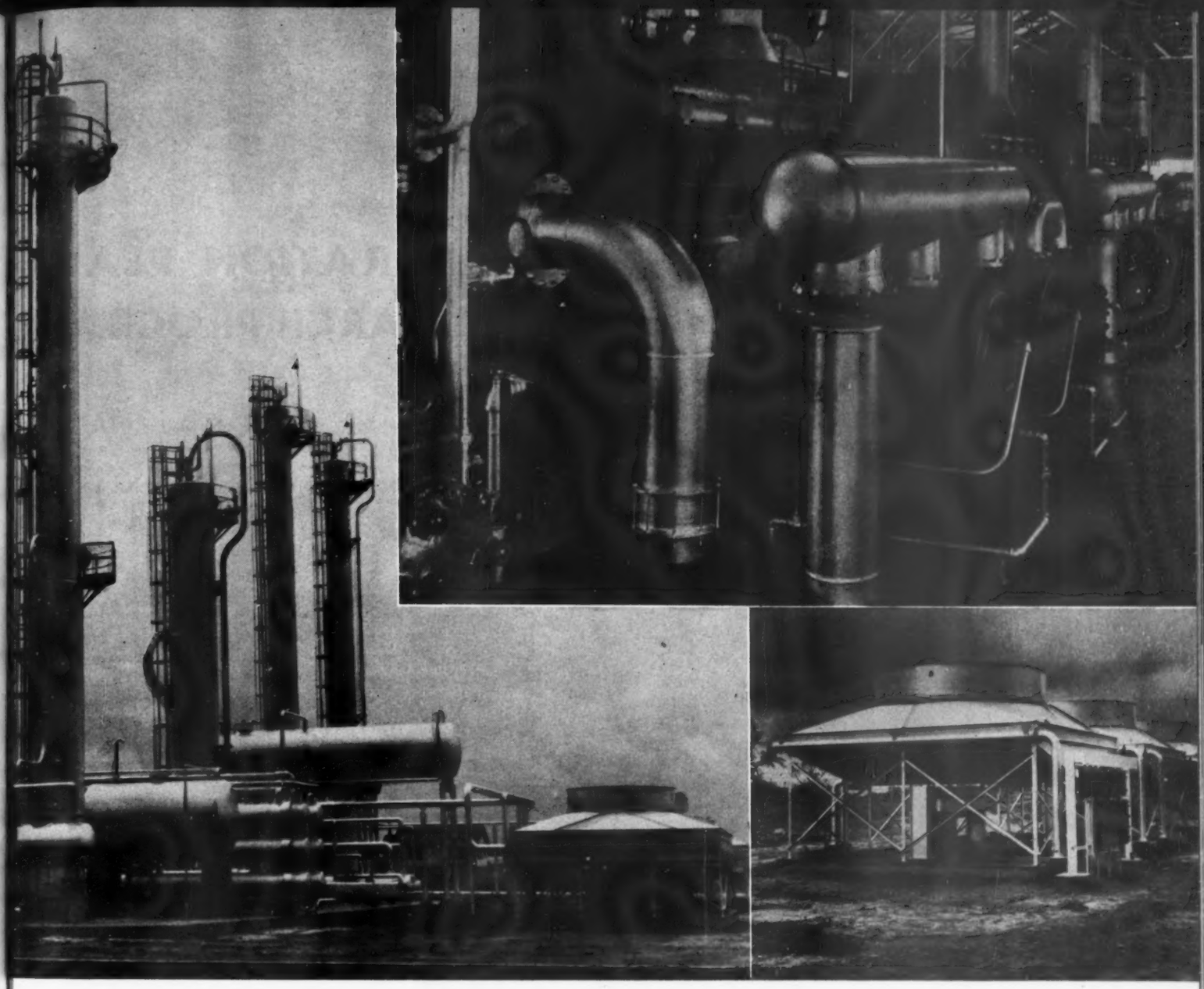
this point or in the still and fractionating system. It is desirable to eliminate the methane and ethane in the absorber-deethanizer since these gases will then be available at top pressure without further handling, whereas, if they pass to the still and fractionating system, they would have to be recompressed back to the absorber for further handling in order to maintain the high degree of recovery of the propane and butanes.

For these reasons, a stripping or deethanizing section has been incorporated into the bottom of the absorber. The cold rich oil from the absorption section flows over heat exchange trays at the top of the deethanizing section to a total draw-off pan. From the draw-off pan, the rich oil is picked up with a pump and circulated through the rich oil-lean oil exchanger back to the deethanizing section. The preheated rich oil then flows down over bubble trays and is stripped of substantially all of the methane and ethane it contains by passing a small amount of propane up through the stripping trays. The propane and butanes stripped out along with the methane and ethane are recovered by reabsorption in the absorption section, and finally return to leave the tower in the deethanized rich oil.

The deethanized rich oil flows through a direct fired rich oil heater into the lean oil still. In the still, the propane, butanes and natural gasoline are stripped out of rich oil, and flow overhead through an air condenser-cooler to the still reflux drum. From this drum, warm reflux is pumped to the top of the still and the liquid and vapor product from this drum is further cooled and condensed with a water cooler before flowing to the raw gasoline surge drum. Total condensation is normally realized in the surge drum because of the operation of the deethanizing section in the absorber-deethanizer. The flow sheet shows a small compressor at this point to take care of possible propane vapors existing during days of extreme summer heat, when the natural gasoline and butanes would not be able to hold all of the recovered propane at the higher temperature in the reflux drum when operating under pressure conditions required for complete stripping of the lean oil.

Hot lean oil is withdrawn from the bottom of the lean oil still and is used to supply all of the plant heat requirements. It flows to the reboilers of the fractionating equipment, then to the rich oil-lean oil exchanger, and finally through the lean oil cooler back to the lean oil surge drum. From this drum, it is picked up with a lean oil pump and circulated to the top of the absorber. A direct fired continuous oil purifier has been provided to condition the lean oil leaving the bottom of the still.

Stripping of the lean oil in the still is accomplished by introducing propane, vaporized by exchange with hot lean oil, into the bottom of the stripping section. Originally it was planned to strip the lean oil with butanes rather than pro-



bove from left to right: absorber-deethanizer, still, depropanizer and deethanizer. Upper right: four 600 hp. Worthington compressors handle 15 million cubic feet of gas daily.

Battery of air coolers made necessary by short water supply.

pane, but this was found to result in a falling off of the over-all butane recovery of the plant, since a high enough concentration of butanes was built up in the stripped lean oil to appreciably lower the recovery of butanes in the absorber. For the propane recovery required in this plant, the use of propane as a stripping medium has proved entirely satisfactory.

Raw gasoline, in the raw gasoline surge drum, is picked up with a charge pump and flows through a preheater to the depropanizer tower. This tower operates in the conventional manner, being water cooled at the top and reboiled at the bottom with hot lean oil. This depropanizer is operated at a pressure sufficiently high to produce liquid propane as an overheat product. The depropanized bottoms, from the depropanizer tower, flow directly into the debutanizer tower. This tower also is operated in the conventional manner, except that all of the overhead cooling is carried out with air coolers. The overhead liquid product from this tower constitutes the butane production from the plant, and natural gasoline is withdrawn as a bottom product. Operation of the debutanizer is regulated to produce the desired Reid vapor pressure natural gasoline.

Table No. I show the analyses of both the inlet wet gas to the plant, and the absorber dry gas leaving the plant, together with the quantity of each of these two gas streams. Also shown in this table is the analysis of the liquid propane product. It is of interest to note from this analysis that the purity of the propane is slightly better than 90%, without the incorporation in the plant of a separate deethanizer tower. This reflects the completeness of demethanization and deethanization of the rich oil in the deethanizer section of the absorber.

All electric power for the operation of pumps and other mechanical equipment, as well as electricity for the lights and instruments, is produced with gas-engine driven generators. All the gas compressors are also gas-engine driven. A closed, air-cooled jacket water system has been provided for the compressor and engine jackets on the gas compressors and generators, and air cooling is also provided for the compressor and generator lubricating oil.

TABLE I

TYPICAL ANALYSES

Component	Inlet Wet Gas (Mol Percent)	Absorber Dry Gas (Mol Percent)	Propane Product (Mol Percent)
Methane	65.6	81.0	0.5
Ethane	10.0	11.5	6.5
Propane	11.9	11.5	90.2
Isobutane	1.4	0.1	1.1
Normal Butane	5.3	..	1.7
Isopentane	1.9	..	..
Normal Pentane	2.3	..	..
Hexanes Plus	1.6	..	..
Total	100.0	100.0	100.0
Cubic Feet Per Day	15,000,000	12,500,000	.....

ETHYL CORPORATION PLANS GREATER RESEARCH PROGRAM

Entrance to Detroit research laboratories of Ethyl Corporation.

AT the close of the recent American Petroleum Institute meeting Ethyl Corporation held open house for oil and automotive technologists at its research laboratories at Detroit. Approximately 1000 accepted Ethyl's invitation. The open house was in the nature of a delayed house-warming which could not be held when the laboratories first were opened within a few months after Pearl Harbor. Ethyl had offered its entire facilities to the government for confidential war work and only those with immediate problems visited the laboratories.

Now that the war and the most pressing reconversion work is over, Ethyl felt free to invite its friends in to see the plant and equipment and to get some insight into the post-war research program which has been laid out by Earl Bartholomew, manager of the 25-acre establishment.

At a recent meeting of the Society of Automotive Engineers Mr. Bartholomew indicated the areas which he believes future researchers should explore. In the same address he suggested what he thinks such studies can accomplish. Perhaps foremost in his view will be an increase in gasoline mileage by about one-fifth within the next few years. Such an improvement in gasoline mileage would permit the operation of 5,000,000 additional automobiles in the United States without increasing crude production. This advance thus would take its place along with better secondary recovery methods and higher refinery yields as a true achievement in the conservation of natural resources.

Although the Ethyl Corporation's interest centers on improved motor fuels the research laboratories do not restrict their studies to fuels. Work of the 336 men at the Detroit laboratories is based on the premise that "the problems of fuels, lubricants and engines are inseparable." A large placard bearing those words greeted every laboratory visitor during the recent open house and Mr. Bartholomew has often said that the design for a successful internal combustion engine involves three basic factors: (1) Dimensions of the parts and of the overall structure, (2) composition of the component parts, and (3) properties of the fuels and lubricants which will be used.

In earlier days of the industry the three phases of the problem were more independent but as power plants have become smaller and more efficient, concurrent changes in fuel and lubricants have been essential. The three design factors have become inseparably interlocked. Dimensions and weights of parts and of the power plant as a whole depend on engine materials and on fuels. The selection of metals for engines is dictated to a large extent by the chemical reactions of the fuels and lubricants under operating conditions expected to be encountered. The refiner must produce lubricants and fuels containing additives to meet severe operating conditions and denuded of corrosive substance which would tend to cause trouble.

In all of the test work done by Ethyl's researchers both in the laboratory and on the road, engine condition is examined minutely both before and after runs. To do this it has been necessary in some instances to develop special equipment as well as special techniques. A gauge developed by Ethyl, for example, measures cylinder bore dimensions accurately to 0.0001 inch. An Ethyl valve grinder is capable of accurate machining within 0.0005 inch.

Much of the motor testing is carried on over very long periods—some to destruction of vital motor parts in order to discover what the ulti-

Earl Bartholomew, general manager of Ethyl research laboratories.

mate effect of lubricants, fuels or excessive loads may have on engines. As a check on motor conditions, engine parts are subjected to stress in corrosive atmospheres and elevated temperatures in specially designed apparatus.

Laboratory procedures are tied in with road testing as fully as possible both at Detroit and on the principal road testing grounds at San Bernardino, California. This year, for example, the test fleet will operate 2,449,000 miles. At the end of 1946 Ethyl road test units will have traversed 45,345,900 miles since the research program first was begun. The Detroit fleet will have operated nearly three million miles, the San Bernardino fleet 5.5 million miles and cooperative test fleets nearly 37 million miles.

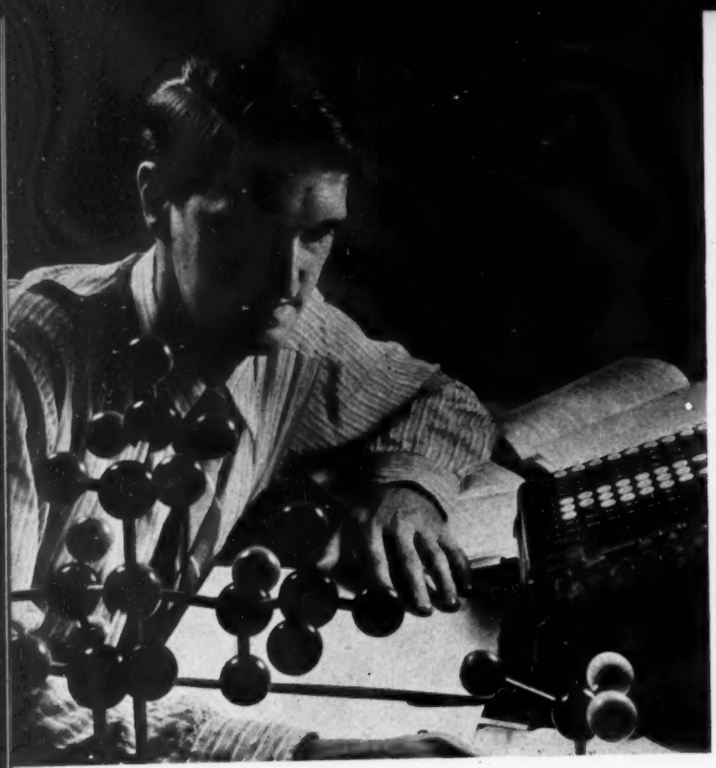
In many instances road tests are reproduced in every particular in the laboratory with the aid of a special apparatus designed by Ethyl researchers. The apparatus was built out of parts of a player piano and is so arranged that all engine controls are operated pneumatically. When it is desired to reproduce a road test exactly the laboratory force prepares a plastic tape by puuching holes like those on a player piano roll. This is done from records made during the course of the original road test. When the roll is fed through the apparatus the motor starts, accelerates, stops and encounters changes in loading and speed in exact sequence and value.

Engine speed and throttle opening are controlled from a roll of perforated tape 6½ inches wide; the tape travels across a tracker bar having twenty-five holes of which twenty are connected to small bellows all of equal stroke and five to larger bellows each having different strokes. The entire system is maintained under constant vacuum by a vacuum pump, so that a bellows is actuated when a perforation in the tape uncovers a hole in the bar. Mercury switches operated by the small bellows cut in various resistances in the generator field circuit of Ward-Leonard dynamometers or the dynamometer field of induction type machines; thus, twenty values of field voltage from zero to full field are available for control of engine speed.

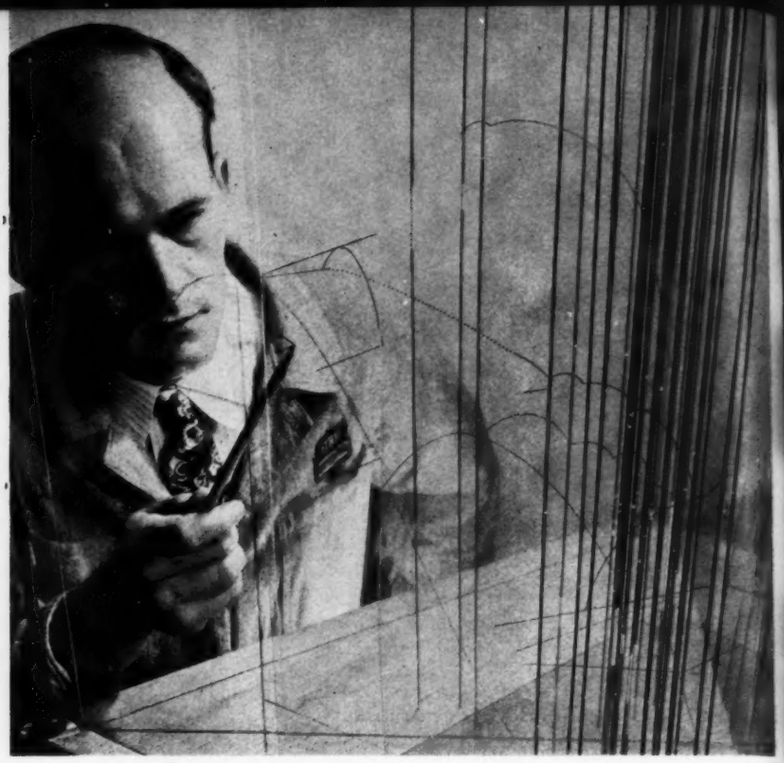
The throttle setting is controlled by the five larger bellows. This arrangement, through use of different combinations of the five large bellows, provides a total of 31 different throttle settings in increments of 3/32 of an inch of throttle actuator travel. With a punching machine resembling a typewriter, blank tape may be perforated according to any desired pattern, so that the apparatus will adjust the engine throttle opening and the dynamometer load to match the sequence and duration of conditions of engine operation in any type of actual service. Records of the speed and inlet manifold vacuum of engines during actual road service may be used as guides in the preparation of control tapes, and apparatus which will obtain such records automatically is now under development. The control tape may be used either with the ends joined to form a continuous band, for automatic repetition of a schedule, or as a roll which is transferred during use from one spool to another if automatic repetition of the cycle is unnecessary, or is impractical due to the length of tape used.

In the case of weather extremes such as temperatures and wind velocities it is, of course, necessary to resort to laboratory equipment in order to carry out any sustained investigations. Ethyl's Detroit laboratories are equipped with hot and cold rooms. The hot room can be maintained at any temperature between 25° and 150°F. Air speed in the room may be varied between 0 and 100 miles per hour. Air speed may be controlled in line with rear wheel speed so that radiator cooling will be identical with road conditions. The cold room may be maintained at any temperature between —50° and +150°F. With a 100-ton refrigeration compres-

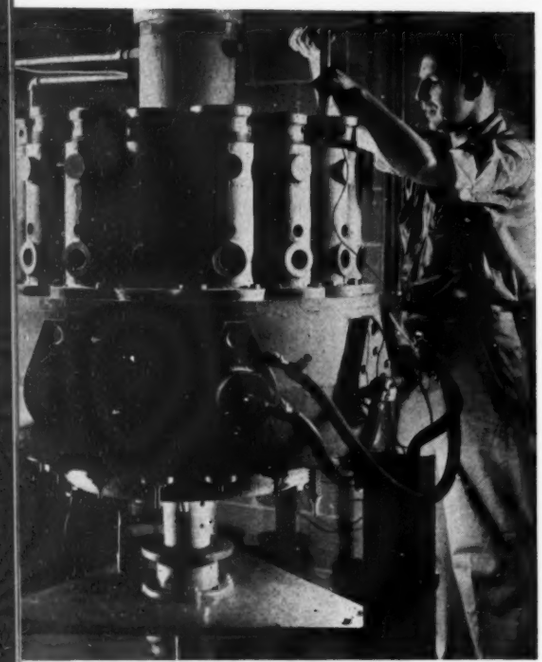
Much of the road testing is done near San Bernardino, Calif.



Atomic models are used in fundamental studies.



Complex data often are charted on three-dimensional graphs.



Massive device for testing engine parts under stress in corrosive atmospheres and at high temperatures.

sor, cooling is such that a passenger car with 320-inch engine can be operated at 60 miles per hour road speed and 0°F. air temperature. Air resistance and road friction can be simulated.

Permanently installed in the engine laboratories are 17 engine dynamometers ranging in absorption capacity from 7.5 to 450 horsepower.. Fourteen of these are double-ended so that tests may be running on one end while the engine at the opposite end is being worked on. For preliminary screening in durability tests, ten Series 30 knock testing engines have been modified and placed in another room. Seven engine dynamometers are arranged in individual rooms for special studies. At the time of the openhouse a tractor engine was being tested for optimum compression ratio, a cooperative test with passenger car engine manfacturer was in progress for a similar purpose, a truck engine was being supercharged, a large bus engine was under test and fuel distribution and manifold deposit tests were running.

Among the many single cylinder test engines installed in individual rooms is one CFR L-head engine with special ionization pickup in the combustion chamber. The ionization apparatus indicates timing in crankshaft degrees for ionization at any pick-up and counts wild pings.

Electronic devices are used in many of the operations. The oscillograph is used to show the exact point where knock occurs in the combustion cycle. Electronic spark advance indicators are employed.

For five years the Ethyl laboratories have done fuel rating work on API and NACA Project 45 in special engines developed by Ethyl. These are 17.6 cubic inch supercharged engines which can be operated at constant speeds ranging from 200 to 3000 RPM. As little as a single cupful of pure hydrocarbons may be tested accurately on these engines. These engines are operated 24-hours per day on endurance tests on aviation spark plugs, on aviation fuels and additives.

A new research project just getting under way at Detroit is on fuels for jet engines. Flame characteristics and blow-out tendencies of fuels will be studied.

A pilot plant for the manufacture of TEL compounds is installed in the chemical laboratories. Although nothing superior to lead as a knock suppressor has been found by researchers in a quarter of a century of work, there have been eight different mixtures sold under the Ethyl brand, not counting aviation fluids. Another variation in the compound is showing good possibilities in current testing.

One of the first research programs undertaken by Ethyl after V-J Day was the road testing near Detroit of catalytically cracked gasolines from war plants. With the cooperation of eleven oil companies 20 different gasolines were tested clear and with 0.5, 1.5 and 3 ccs. of Ethyl fluid per gallon. The samples included products of all of the catalytic processes.

In the fleet of cars employed in the tests was a Chrysler with 8.5 to 1 and 9.4 to 1 compression ratio heads and a Buick with 8.0 to 1 and 9.0 to 1 heads. These high compression heads were selected so that the war-developed gasolines could be tested to their utmost without resorting to excessive spark advance.

Cars for road testing are equipped with a variety of instruments for recording operating conditions. Mileage is recorded accurately with a fifth wheel. Speed of the engine is reported by a tachometer on the steering wheel. Beneath the dash is a device for adjusting the spark settings during the test run. An electronic unit reports and records engine temperatures at various points and other data such as spark advance. Elaborate equipment is provided for changing fuels and measuring quantities consumed.

Since large quantities of many types of fuel are needed by the engine laboratories and road test

Engine performance and endurance characteristics are tested on this group of dynamometers.

Rear view of dynamometer panel showing complexity of wiring, tubing and other instrumentation used in today's research.

sections, a separate building houses equipment for blending and distributing fuels. Thirty-four underground tanks, ranging in capacity from 500 to 10,000 gallons, store the gasoline, the total storage capacity being 75,000 gallons.

From each of the buried tanks two lines lead to the fuel building. Anti-knock fluids may be blended with gasoline in any underground tank and the fuel may be transferred from any tank to any other tank, or may be supplied to any engine on test by means of automatically-controlled pumps.

Throughout the fuel building safety precautions have been taken. All electrical connections — lights, motors, telephone, switches, ventilators — are explosion-proof. A deeply buried tank is large enough so that the contents of all other tanks may be drained into it by gravity in case of emergency.

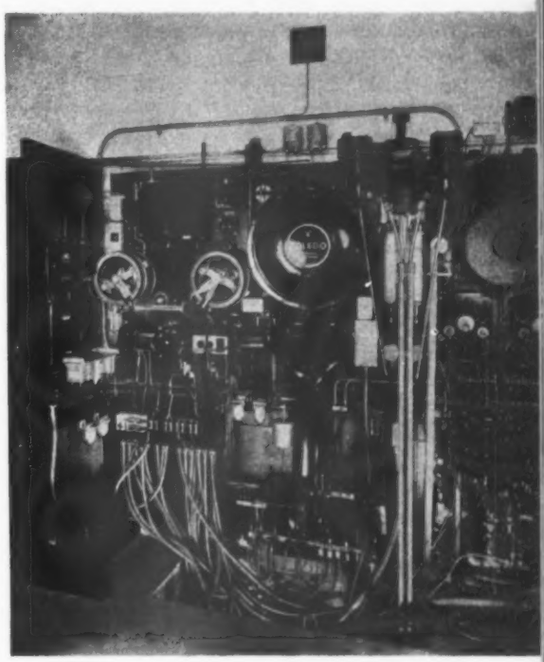
The new laboratories represent the second move since the establishment of research facilities in the early days of the corporation. Originally located in Yonkers, N. Y., the laboratories were moved later to Milwaukee Avenue in Detroit. The quarters there became inadequate as the problems of automotive, fuel and anti-knock development grew in number and complexity.

Many of the oil company research men who visited the laboratories during the open house expressed interest in one of the least spectacular items of equipment displayed. This was a device for blending small, accurate quantities of Ethyl fluid with test samples of gasoline with entire safety for the operator.

A feature of the laboratory inspection was the unveiling of a bronze tablet placed in the reception room to honor the memory of the late Thomas Midgley, Jr., discoverer of tetraethyl lead as a knock suppressor. Each visitor was given a booklet containing an appreciation and the life story of Mr. Midgley written for the occasion by Charles F. Kettering of General Motors, his long-time research associate.

The laboratories include complete auxiliary facilities, such as shops for metal working, wood working, painting, electrical repair and general maintenance, as well as sections concerned with photography and the development of instruments and experimental apparatus. A combination cafeteria and auditorium, and both indoor and outdoor facilities for employee recreation and provided.

Before the war the octane number of motor gasoline was rising at the rate of about one number per year. There was a loss in quality during the war but with reconversion of refineries after V-J Day gasoline quality no only recovered its war-time losses but had reached new levels of quality on the pre-war trend line. The best fuels on the market early in the year were as high in octance number as the average predicted for 1950 by extrapolation of the trend line. The current lead shortage has changed this condition but obviously the situation is temporary and fuel quality will rise rapidly when lead is available. This intensifies the necessity for engine research to make economic use of the fuels of tomorrow from catalytic cracking. So the 300-odd researchers at Ethyl's Detroit laboratories are looking forward to a busy time helping manufacturers build better engines and oil refiners meet the stiff competition of war-built processes.



Fuel system distributor by which any two fuels from underground storage or drums can be supplied to multi-cylinder engine dynamometers.

ASTM UNDERTAKES DI

New 6,000 hp. diesel-electric locomotive built by American Locomotive Co. for crack Santa Fe passenger trains operating between California and Chicago.

CATALYTIC cracking and the greatly increased demand for light distillates as fuel oil have brought about reorganization of Technical Committee F on diesel fuels of the American ociety for Testing Materials. Under the chairmanship of C. H. Rosen of Caterpillar Tractor Company, the committee will sponsor an active investigation of the subject which many engines and oil men consider critical.

To formulate the problem concretely the committee held a public forum in Chicago during the recent American Petroleum Institute meeting. Principal consumers told the oil industry what they want and representatives of petroleum refiners reported on the current supply outlook. In the course of the discussion the consumers expressed considerable alarm regarding the diesel fuel price trend, quality of product available and the future supply. Oil industry men countered that consumers will have to meet the competition of domestic fuel oil and gasoline markets but that the industry can meet any anticipated demand in the immediately foreseeable future.

R. H. Morse, Jr., vice president of Fairbanks, Morse & Company, took the oil men to task for wasting high quality straight-run diesel fuel in gun type oil burners when cracked fuel will serve as well. He pleaded that oil should be put to its most efficient use regardless of present profit and warned that the industry now is pricing the diesel engine out of the market.

In 1920 installed diesel horsepower in the United States was 1.25 millions, Mr. Morse reported. In 1936 operating diesels developed nearly nine million horsepower and in 1944 this had risen to 95 million horsepower. In 24 years the use of diesels was multiplied 97 times. It should double again in the next ten years.

"We are already a pretty good customer for petroleum products and we show every promise of becoming an even better one," Mr. Morse said. "Let's consider our present use of lubricating oil. We estimate the diesels now in use at 97 million horsepower, and the average annual operation of each engine at 5,000 hours. This figures to 24.25 million gallons of lubricating oil, and you are selling this oil to us at fifty cents a gallon. From various sources, we have heard that you like to sell us lubricating oil at fifty cents a gallon—that you consider our annual lube bill of $12 millions a profitable item of business.

"If we are going to buy this lube oil of you, we must have fuel oil in proportion. That proportion figures today to nearly 2.7 billion gallons, and our fuel bill for the year comes very close to $150 millions. This seems like a tidy return on the by-product which we have been buying from you, but now we learn with dismay that you have found a better customer for it.

"For the eternal glory of your 1946 income statement, you choose to direct all research and effort toward increasing the amount of high octane gasoline to be squeezed out of each gallon of crude. In your newer processes, the good grades of diesel fuel and furnace oil are fed to the cat-crackers as charging stock—unless the diesel users are willing to pay a higher price so that it will be economically attractive for you to sell us this fuel rather than convert it to gasoline.

"The petroleum industry suggests to the diesel industry that we redesign our engines in such a manner that they will operate successfully on the new by-products of the new processes of gasoline manufacture. We built our industry to use your old by-products, and perhaps we can rebuild it to use your new ones. In any event, we are trying to do so with all available research and speed, but this is little consolation to the users of the hungry 97 million horsepower of diesel engines already in existence who see their vital fuel supply being priced out of their reach.

"The world has become diesel conscious because of the economy of this engine. We figure the 150 million dollar annual fuel bill of American diesels in fractions of a penny, because the performance of the diesel is predictably consistent to the point where a fraction of a penny can mean the difference between profit and loss in efficiently run industry, commerce or utility. Power competition is keen, the diesel has won its foothold honestly, price fluctuation in diesel fuels will invite chaos.

"The new substitute which you ask us to use in place of our accustomed fuel has poor ignition qualities and other undesirable features. The au-

DIESEL FUEL STUDY . . . .

tomotive high speed diesel is highly sensitive to the quality of its fuel. If the worst is true, automotive diesel users may be compelled to pay the higher price for the fuel they are now receiving —and like it.

"The larger diesels can survive on a poorer fuel, if this is the alternative, but we ask you sincerely to turn your great research facilities toward giving us for these engines an adequate supply of the best possible fuel—at a price that the national economy can afford to pay. Remember, too, these big engines are one of your good lube oil markets.

"You may accuse us of selfishness and poor logic when we ask you to supply us with a product which you can sell to a luxury market at a higher price than we can afford to pay. It is hardly selfish to plead the cause of the most efficient user of a dwindling national resource, when evidence shows that this precious commodity is being squandered lavishly by other of its consumers."

In an eloquent conclusion, Mr. Morse said: "The diesel engine is the most efficient instrument in existence which will convert petroleum into useful energy. It is an ever growing aid in today's economy, and it is a vital necessity to the economy which we must inevitably face in our future. We ask you to recognize the importance of the diesel in any stable picture of future national prosperity and security. We ask you to apply to our problems and our needs of today the full brilliance of your vast research facilities. We ask you to realize that the diesel runs on oil —and that it must be kept running."

W. H. Kelly, general purchasing agent for the Santa Fe Railroad, world's largest railroad diesel fuel consumer, gave the forum a review of the rapid conversion of railroads to diesel power. In 1930 only 4.3 percent of locomotives ordered by railroads were diesels. In 1930 the percentage was 69 and in 1945 it was up to 82. In 1935 the railroads burned 100 million gallons of diesel fuel and in 1945 the total was about 500 million gallons.

Expediting the current research program on diesel fuel quality of the Cooperative Fuel Research Committee was urged by Mr. Kelly who complained that some oil companies have dumped odds and ends of intermediate distillates into a tank and sold the nondescript mixture as either automotive or railroad diesel fuel. He suggested that too much emphasis has been placed on cetane number of diesel fuel and that more study should be given to balancing this with proper volatility and chemical purity. In railroad locomotives good operation can be obtained with fuels of varying cetane number if distillation range is proper and oils are not sour or corrosive. Since more make-up air is being used on air-conditioned trains, odor is becoming increasingly important.

Viewpoint of the bus and truck operators was presented by F. T. Ward, chief engineer of the Third Avenue Transit System in New York, which recently has been adding to its already very large fleet of city buses. Between 1942 and 1945 total U. S. buses in operation increased 22 per cent while diesels increased 33 per cent. In 1945 buses consumed diesel fuels and lubricants costing $107 millions, he said. It will expand rapidly in the future. His own firm has ordered 700 diesel powered buses and one intercity bus company has 1200 on order. One passenger bus manufacturer reports than 92 percent of his current orders are for diesels.

Elimination of smoke and smell are most important to bus operators he said. Thus far all the oil companies have done is to mix kerosene with the fuel and put in cetane additives. The oil industry should have done more research on fuels and less on lubricating oils, Mr. Ward said. The Third Avenue Transit System uses 7.5 million gallons of diesel fuel per year but oil companies resist efforts to set fuel specifications which will eliminate smoke and smell.

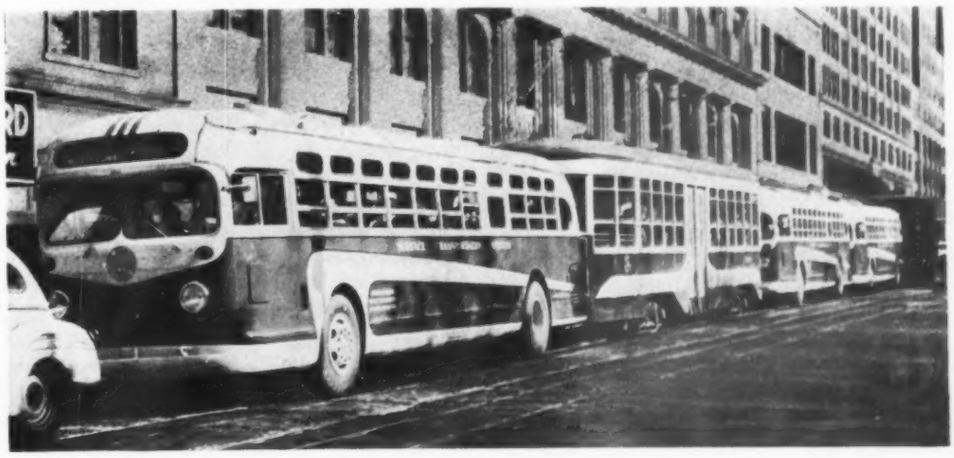
Col. G. H. Vogel, executive officer of the Army-Navy Petroleum Board, suggested that the present impasse be met by:
(a) Improved refining techniques
(b) Use of cetane improvers
(c) Quantity production of high cetane synthetic fuels.
(d) Quantity production of substitute synthetics from gas, coal or shales.

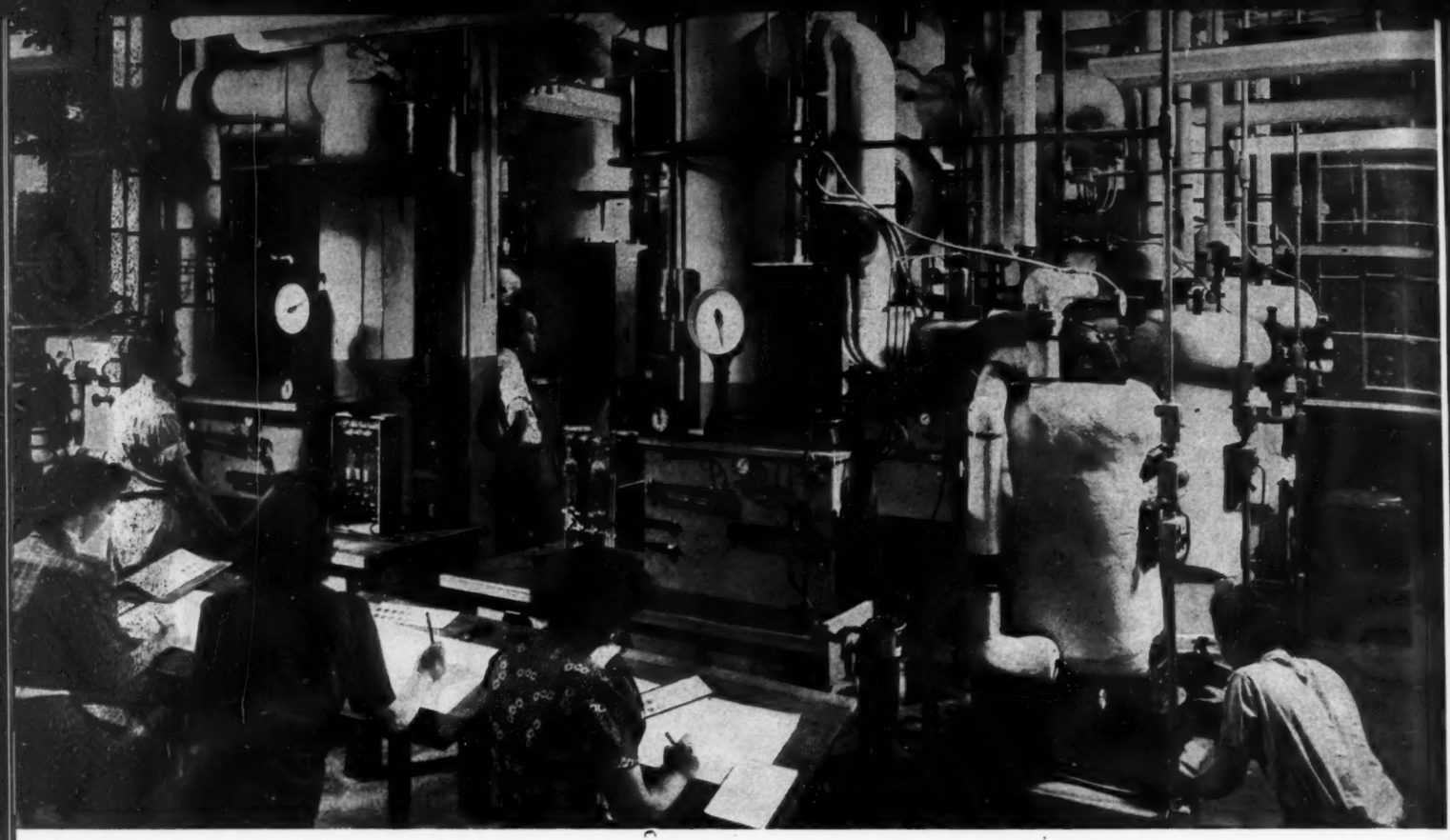
The military will not be satisfied with redesign of motors to use low cetane fuels. Maximum power output with minimum weight is essential for military vehicles. The goal is an increase in cruising range of land and amphibious vehicles from 240 to 1000 miles at high speeds. There will be no military change-over, he said, until future trends of fuel quality and fuel supply are clearer than at present.

Col. Vogel predicted that in any future emergency jet fuel demand would increase faster than any other. The fuel probably will be in the gasoline range but with rigid specification limits. For land vehicles he foresees elimination of clutch and differential and direct drive through turbines on wheels.

Current and future diesel fuel production trends were discussed at the forum by John C. Day of the Western Petroleum Refiners Association, J. E. Keller of the National Petroleum Association and A. G. Marshall of Shell Oil Company. It was reported that distillate yields have increased 87.9 percent since 1938. It has been demonstrated that yield can be brought up to the level necessary to meet demand anticipated at least through 1950. Mr. Marshall told of one experiment in which production was increased 50 percent by sacrificing yields of other products. He recalled Dr. R. E. Wilson's recent statement that the oil industry will provide any fuel for which there is an established demand.

Diesel powered crosstown buses now replacing trolley cars on 42nd street in New York City.





New fuel oil laboratory of Gulf Oil Corp. at Harmarville, Pa., where precise 70-hour efficiency tests are made of various domestic fuels under varying conditions of humidity, barometric pressure and outside temperatures.

DOMESTIC FUEL AND BURNER GROUPS PLAN FOR INCREASE IN DEMAND

EXPANSION of fuel oil consumption for power and domestic heating and the need for revised standards for products so used provided subjects for a panel discussion among members of the marketing group at the Chicago meeting of the American Petroleum Institute. Outlining the probable growth in demand for this class of oils W. A. Matheson of Oil Heat Institute predicted that more than a billion dollars worth of power burners and space heaters would be sold in the United States by 1950.

"Industry surveys during the war years," said Mr. Matheson, "indicated that more than $900 million worth of oil heating equipment would go into American homes by 1950. Conservative estimates pointed to a total of 4½ million domestic oil heat installations by that year. And this is only the power burner side of the picture. The space heating industry with more than 2½ million installations expects to add 750,000 units or better annually for the first five post-war years.

"Each of the 4½ million power burner installations will burn an average of 2,000 gallons of fuel oil a year. Each space heater will burn an average of 650 gallons a year. Counting new equipment sales, service, and fuel oil sales, oil heating will soon become a half a billion dollar a year business! Can anyone in the oil industry afford to overlook it? At this time, with certain materials almost impossible to procure, production can't keep pace with the demand for equipment. During the first seven months of this year, manufacturers shipped 228,872 burners. Yet unfilled orders for the same period totaled 824,335.

"Today, oil heat is the Champ! Oil heat installations outnumber either the gas burner or stoker total by better than 2-to-1. If, however, the oil and oil heating industries are content to sit back and accept the little end of the new home market—then a new champ will be crowned—and soon. Official government figures show that the first 607,000 homes started under the Wyatt program for veteran housing are heated: 52% gas, 27% coal, and but 21% oil!

"What can we do about it? Well, the first thing we can do is for the oil heating industry to come up with some top flight, inspired engineering and design oil heating equipment for the new small-homes market. From now on, dynamic discontent must be the order of the day whenever engineers are concerned with the continuing development of automatic oil heating equipment. Product development, designed to create oil heating equipment for the millions, is long overdue. Now the veterans' housing program brings this to a head. At present prices, oil heating devices are completely shut out from the millions of new homes planned under this program. And that means shut out from the entire small home market. Because veterans' housing is the blueprint for housing Mr. and Mrs. Average American everywhere.

"If we do the right kind of an oil heating job together there can be 6,000,000 oil heating installations at the end of the first five post-war years, instead of the 5,000,000 originally estimated.

"Present plans call for the construction of 12,644,000 new homes in the next ten years. If the public is exposed to an aggressive, consistent presentation of the advantages of oil as a fuel, isn't it reasonable to assume that oil would get at least an even break with gas in these homes? In terms of oil heating equipment, this even break would mean 1,896,600 additional oil burner sales. In terms of oil, it would mean an additional 67,714,285 barrels of fuel oil a year."

Results to date of discussions in joint meetings of oil refiners and oil burner manufacturers arranged by the U. S. Bureau of Standards and looking to a revision of standards for distillate fuels were reported by J. L. Minner of Shell Oil Company, Inc. These conferences, Mr. Minner

Proposed Distillate Fuels

	Flash Point °F		Pour Point °F	Water & Sed. %	Carbon Residue	Distillation Temp., F.				Viscosity		Gravity	Corrosion Copper Strip
	Min.	Max.	Max.	Max.	Max.	10% Point Max.	90% Point Max.	90% Point Min.	End Point Max.	Sayb. Univ. At 100° F. Max.	Kinem. At 100° F. Max.	°API Min.	3 Hrs. at 122° F
No. 1 Fuel Oil													
A distillate oil suitable for vaporizing pot type burners	100 or legal	....	0	Trace	0.10 on 10% Resid.	420	....	....	625	....	2.4(J)	35.0	Pass
No. 2 Fuel Oil													
A distillate oil for general purpose domestic heating(A)	100 or legal	....	20(C)	0.10	0.40(F) 10% Resid.	460(K)	675	....	....	45	.....	28.0	....

Delete present Grade No. 3(A)

Notes

(A) Delete No. 3 grade and change sulphur maximum for No. 2 fuel oil from 0.50% to 0.75%.
(B) No change from CS12-40.
(C) No change from CS12-40.
(J) For use in burners of the gravity feed type requiring fuel of uniform ivacosity, a lower limit of 1.5 kinematic viscosity may also be specified.
(K) The 10% point may be specified at 440 deg. F. maximum when this fuel is to be used in burners requiring a somewhat higher volatility fuel.

said, resulted in the acceptance of two basic facts:

(1) "The trend toward higher octane gasoline, and wider use of the catalytic cracking process, tends to produce lower API gravity distillate fuels for the same distillation range and residual fuel oils of different gravity-viscosity relationships than have previously been available.

(2) "The petroleum industry wants to serve heating needs and recognizes the necessity for supplying grades of oil suitable for oil heating equipment now in use. As a result of changes in refining practices, new heating needs may be served more economically if new home heating equipment is designed to use the lower API gravity, higher heat content fuels in each distillation range, which will be available in increased proportions."

In light of these facts the following recommendation was submitted:

"The refiners recommend to the burner manufacturers, in order that oil heating may be placed on a most economic basis for the consumer, that both vaporizing and mechanical atomization burners, other than those designed to burn kerosene, be designed to burn efficiently a less volatile No. 2 than has been marketed prior to the war."

"It was apparent to the refiners at that time that if the large expansion in sales materialized in burners of the prewar type, it would be difficult if not impossible to supply fuel oils of prewar composition and still fill the expanding demand for other petroleum products; and in the case of vaporizing pot-type burners, there would be a definite shortage of straight run products to supply the large increase in demand.

"Since representation on Technical Committee E of ASTM D-2 Committee on Petroleum Products is divided among oil burner manufacturers, refiners and consumers, this was considered the most logical group to undertake the determination of factual data necessary to the revision of C. S. fuel oil specifications in keeping with the changes in refining techniques. Never before in the history of oil heating have the oil burner manufacturers and refiners joined together in such an extensive undertaking. They tackled the job with real vigor, everyone having in mind that in the post-war years oil heating had to be on the most economical basis to the consumer in order to be competitive with gas. The following work was accomplished:

(1) A forecast of the quality of fuel oils which would be available for general postwar use.
(2) Establishment of specifications for prototype fuels for actual testing in the various burners.
(3) Formulation of burner testing procedure for the various laboratories engaged in the program.
(4) Actual burning of these oils under a wide variety of operating conditions.
(5) Tabulation of all the data.
(6) Interpreation of the data as a basis for revision of specifications.

"More than 30 laboratories engaged in this program. All types of oil burners were tested. Factual data have been obtained, the wild rumors regarding the new cat cracked fuels have been dispelled, and on the basis of these findings, the Committee now has under consideration definite recommendations from the working groups for revisions in domestic fuel oil classifications. These revisions should adequately take care of existing burners as well as those of the future which in all probability will be of greatly improved design.

"In addition to kerosene, which is still required for use in sleeve-type and wick burners, the recommendations provide for the establishment of two grades of fuel oil for domestic heating to replace the present Commercial Standards' Nos. 1, 2 and 3 oils. One grade (the lighter of the two) would be intended primarily for use in vaporizing pot-type and the more critical wall-flame burner installations, while the heavier grade would be suitable for use in the less critical wall-flame and high and low pressure atomizing burners. A maximum Conradson carbon residue of 0.10% on the 10% bottoms and minimum API gravity of 36.0 have been suggested for the new No. 1 fuel, while the end-point would be raised to 625°F., and the maximum flash point of 165 deg. F. eliminated. As additional requirements, a maximum viscosity of 2.4 centistokes at 100 deg. F., and the ability to pass a copper strip test of three hours at 122 deg. F. have been suggested.

"The specifications for the fuel oil which would replace present Commercial Standards' Nos. 2 and 3 fuel oils represent a compromise between these two grades. These specifications include a maximum carbon residue of 0.40% on the 10% residue, maximum 0.10% B.S. & W., and maximum distillation temperatures of 460 deg. F. and 675 deg. F. for the 10% and 90% cuts, respectively. Added requirements would be a minimum API gravity of 28.0 and a maximum viscosity (Saybolt Universal) of 45 seconds at 100 deg. F. The minimum flash point would be reduced to 100 deg. F. or legal, and the maximum flash point requirement eliminated.

"In drawing up these proposals, the Committee has taken the viewpoint that the specifications should not be restrictive in the sense that acceptable oils are barred by failure to meet the specifications. Accordingly, kerosene and range oil in general meet the specifications for the No. 1 fuel oil and could be supplied as such where facilities do not exist for handling both kerosene and No. 1 fuel oil. The proposed minimum API gravity limits would classify the fuels with regard to carbon-hydrogen ratio which, together with volatility, affects the fuel performance in many burners, but would not be restrictive of supply. The classifications neither specify nor imply a ceiling on quality, thus assuring complete freedom for the play of competitive forces in determining actual quality delivered to the consumer.

"The full report of the subcommittee has been submitted to the membership of Section III, Technical Committee E, Committee D-2 of the ASTM and such comments as have been received on the proposals have in general been favorable. The proposed specifications, however, have not yet been adopted.

"The two new grades, plus kerosene, should adequately meet the requirements of all types of burners now in use, as well as those of improved design to come along in the future. Under this set-up, marginal burners in any one classification would have the choice of going to the next lighter grade, in cases where the fuel originally intended for use does not give entire satisfaction."

OIL RESOURCES OF SOUTH AMERICA

Estimates of South American Oil Reserves Vary from 7 to 30 Billion Barrels. Such Wide Divergence Reflects the Vast Favorable Continental Areas Still Unsurveyed and Untested

THE situation as regards the known and the probable oil resources of the South American continent may be characterized in a few words:

The surface geology of extensive territories has been thoroughly studied only in a few countries like Argentina, Colombia and Venezuela, and in some of these countries geophysical methods of exploration for oil have not been applied on a large scale. Even in these countries the percentage of test borings in comparison with the extent of the prospective areas is exceedingly small. In other countries of South America the development.

As regards the reserves that may be regarded as fairly sure, these were estimated by Garfias in 1939 at 3,700,000,000 barrels, by Bateman in 1942 at about 5,200,000000, barrels, and by Gester in 1944 at about 7,000,000,000 barrels; another estimate in 1944, by Oppenheim, mentions 30,000,000,000 barrels as a limit that may be attained after all probable areas shall have received proper attention by adequate petroleum exploration programs. Much of these probable areas may be quite unprofitable under present conditions, due to inaccessibility and great distances from ports; but considered from the standpoint of world reserves are very important.

If the petroleum reserves of South America are to be raised from Gester's estimate of 7 billion barrels to the Oppenheim estimate of 30 billion barrels, the increase must come from two sources: deeper drilling in known areas and, more importantly, from the large areas that may be regarded as good or fair prospecting territory.

These prospective reserves, if they exist, will be found after many more geological field investigations and above all more borings have been made in the many and vast and deep sedimentary basins of the continent.

As examples of vast areas forming part of marine basins favorable for oil accumulation there may be mentioned the following: Southwest Llanos of Venezuela; the Atlantic and Pacific coastal basins of Colombia; The Llanos of Colombia; The north Pacific Coast of Ecuador; The "Oriente" east of the Andes of Peru; upper Amazon and Acre basins of western Brazil; The vast territories east of the Bolivian Andes; The western Chaco of Paraguay and Argentina; The Magallanes basin in southernmost Argentina and Chile. These are some of the important marine sedimentary basins that have hardly been investigated geologically, and some of which have never been tested. It will be of interest to mention some particulars of these prospective areas that invite more detailed study.

In Argentina, producing oil fields have been developed in the Comodoro Rividavia region (Chabut territory), Plaza Huincul (Neoguen territory), Mendoza and Salta Provinces. The deepest drilling in Argentina reached 10,048 feet, in the Tupungato field, but elsewhere in the country very few holes have gone beyond 6,000 or 7,000 feet, and what remains to be found by deeper drilling in the proven fields is yet to be seen. There are still vast territories in Argentina that require further exploration and test borings, particularly along the Andean front ranges, the great Chaco basin in the north, and the promising areas of the south, such as the Santa Cruz and Magallanes basins.

In most of Chile the geological conditions are rather unfavorable for oil accumulation, but in the southernmost region (Magallanes) there is an exceptionally thick and favorable sedimentary cover south of the 52nd parallel. Here oil seepages and impregnations have been recognized; shallow borings have found small accumulations, 12 new structures have been located on the mainland in Tierra del Fuego, where oil may be expected at about 2,500, 3,500 or 6,000 feet. Quite recently a wildcat well in the northeast of Tierra del Fuego found what appears to be commercial oil at 7428 feet from a 10-foot sand. The showings of oil are very encouraging and the oil is of high quality. It is highly probable that this discovery will develop into an important field, which again proves that borings in untested areas are indispensable for new discoveries. Development here has largely been delayed by accidental circumstances and lack of modern scientific investigations, which are now being overcome.

Petroleum production is as yet unknown in Uruguay, and the country possesses only one sedimentary basin that could be considered encouraging for oil. The stratigraphic characteristics and general shallowness of this basin have been confirmed by many borings, but commercial production has not yet been found. Elsewhere in Uruguay the Permo-Triassic rocks, although associated with some bituminous shales, lack potential petroleum accumulations. The conditions as regards the Gondwana rocks are similar to those in Brazil but conditions here are aggravated, from a petroleum viewpoint by the relative shallowness of these rocks.

Petroleum production is also unknown in Paraguay. As regards the Permo-Carboniferous glacial beds and the Devonian, the possibilities here are of the same nature as of the Brazilian Parana Basin. The Paraguayan Chaco is unknown geologically, except for what may be inferred from the neighboring Bolivian and Argentinian Chacos. In those regions there are conspicuous structures that may extend into the Paraguayan Chaco, and might yield oil if not at too great a depth. The large structure known as the Chorata High recently discovered in the Argentine Chaco may extend into Paraguay. An unsuccessful test was drilled in 1944 and was abandoned at 5600 feet; it is evident that such a test is not final, and an intensive test may reveal the presence of large petroleum accumulations in the Chaco basin, which could completely upset the accepted notions about the petroleum geology of this vast region.

In Bolivia there are three producing fields that extend along the front ranges of the Andes in the southeast. Up to date, the deepest wells do not exceed 3500 feet, and many are around 2000 feet. There is a possibility of finding broader and larger structures farther to the east along the western limits of the Chaco. Another vast region of petroleum possibilities comprises the northeastern part of the Bolivian front ranges in the upper valleys of the Beni and Madiai rivers up to the Peruvian border in the territory known as Caupalican, which is as yet without accessible communications. The petroleum possibilities of the rest of Bolivia to the west of the front ranges are rated as improbable.

In the territory of Acre there exists favorable geological conditions for large accumulations of oil. The Acre basin, which is near the border of Peru, contains a stratigraphic column of Tertiary-Cretaceous sediments like the one in the Peruvian Agua Caliente oil field. The most conspicuous structure is the Moa anticline, which may or may not reward test borings; deeper buried structures should be sought for and tested by geophysical methods; aerophology would help here. The test borings that have been made on the Upper Jurua river seem to have been inadequately located. Up to date, little has been added to the geological knowledge of the Acre territory since 1935.

[1] Abridged from a paper by Victor Oppenheim; Geologic outline of South American oil fields, published by the United States section of the Pan American Institute of Mining, Engineering and Geology.

PANAMA
TRINIDAD
MARACAIBO BASIN
CATATUMBO
VENEZUELA
CASABE
INFANTAS
LA CIRA
BOGOTA
BRITISH GUIANA
FRENCH GUIANA
DUTCH GUIANA
COLUMBIA
ECUADOR
ANCON
ZORRITOS
LOBITOS
TALARA
PERU
GANSO AZUL
LIMA
BAHIA
BRAZIL
LA PAZ
BOLIVIA
CAMIRI
CAMATINDI
SANANDITA
BERMEJO
BALTA
RIO DE JANEIRO
HILE
PARAGUAY
URAGUAY
SANTIAGO
MENDOZA
BUENOS AIRES
MONTEVIDEO
ARGENTINA
PLAZA HUINCUL
COMODORO RIVADAVIA
TIERRA DEL FUEGO
TERTIARY BASINS
AND
OIL FIELDS
OF
SOUTH AMERICA
Tertiary Basins
Oil-Field Basins

The great Amazon basin, extending from the mouth of the Amazon river to the boundaries of the neighboring countries in the west, is as yet lacking in adequate geological investigation, and its petroleum possibilities are thus as yet unknown. A few shallow wells drilled in the Devonian section of the basin are inadequate for a final opinion on this vast area.

The much discussed Parana basin in southern Brazil undoubtedly possesses source rocks which are highly petroliferous, such as the Permian Iraty shales. Reservoir formations and structures are also abundant in this basin. However, the great igneous activity in early Mesozoic (Triassic) times resulted in one of the most vast known outpourings of basaltic lavas, which now cover the greater part of the Parana basin in southern Brazil and the neighboring countries of Uruguay and Paraguay. The many test-borings made along the eastern sedimentary edge of the basin have not shown any large accumulation of petroleum.

Since there is a 2000-foot cover of lava over the greater western part of the basin, the stratigraphic conditions below this cover will remain speculative until test-borings are sunk through the lava flows down to the underlying sediments of the basin.

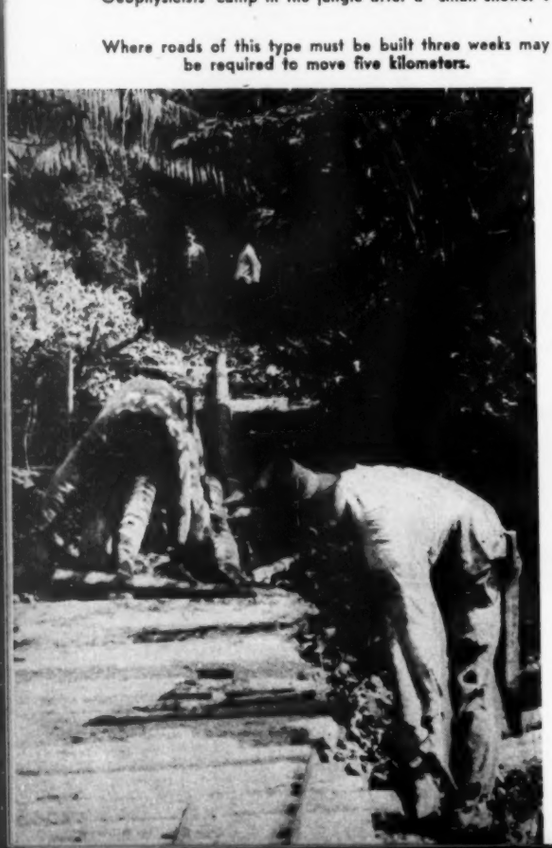
Although it is known from surface geological studies along the eastern sedimentary edge of the basin that both Permiam and Devonian source rocks are present, and that these rocks are intensively fractured, no active oil seeps have been found.

The so-called Pianhy and Moranhao basin in the northeastern part of Brazil has thus far shown mostly continental Paleozoic sediments, and at the present stage of geological information seems to be inadequate for large petroleum accumulations.

To sum up, the Brazilian oil problem can only be solved by more thorough studies with modern methods and a far more intensive drilling campaign.

Geophysicists' camp in the jungle after a "small shower".

Where roads of this type must be built three weeks may be required to move five kilometers.



In Peru, oil is being produced in two widely separated regions: The northwest coastal region, and the Rio Pachitea area in the Amazon basin. In the coastal fields the producing horizons are of Tertiary age overlying Cretaceous sediments. The total number of wells drilled in the coastal fields is estimated at about 5000; the deepest test is about 10,000 feet; the average depth is 3000 feet. These fields occupy a relatively narrow belt along the coast. Promising possibilities could be expected from a vast territory south of the Rio Chira, which includes the Seohurd desert and adjoining areas south of Piura.

The Agua Caliente field east of the Andes, where six wells have been drilled, is bordered to the north and east by widely spread Tertiary Red Beds where the Agua Caliente anticline is formed in upper Cretaceous sandstones and shales. The thickness of the oil sands is 30 to 130 feet. There appear to be great possibilities for petroleum development in this region. However, due to the inaccessibility of this region, its isolated geographical position, and the dense tropical vegetation, its development will meet with difficulties and its petroleum reserves will probably be developed only at some future date.

An interesting area known to be oil-bearing extends along the northern shores of Lake Titicaca, where desultory drilling was carried on from 1906 to 1919. The Peruvian government is now doing some drilling in Pirin, small amounts of oil but no commercial production has been found in these tests, which have not passed beyond 1000 feet. The regional geology shows Tertiary Cretaceous and Devonian formations but precise geological information on this area is still lacking.

At present, nearly the whole oil production of Ecuador is from the Santa Elena peninsula on the Pacific coast. North of Santa Elena there is a great extension of the coastal belt, where there is a large area that seems to be quite favorable for oil accumulations, but the potentiality of this belt has still to be proved by more drilling.

The vast territory east of the Ecuadorian Andes is expected to possess large petroleum possibilities. A broad and extensive anticlinal structure on the Rio Arajuno river southeast of the Rio Napo offers highly favorable prospects. In general, the stratigraphy and tectonics of the Ecuadorian "Oriente" have been outlined and numerous favorable structures have been located. The area is covered with Tertiary sediments with a thickness of up to 14,000 feet overlying 4000 feet of Cretaceous sandstones and shales which could be source rocks for "Oriente" oil production.

A separate region is formed by the Cutucu mountain range forming the northernmost extension of the Cordillera Oriental of Peru. This area has been subjected to secondary folding east of the Cutucu range. The Napo limestone of this area is highly petroliferous and is responsible for the numerous oil seeps from faults along the mountain front. However, surface geological work in the "Oriente" encounters considerable difficulty from the dense forest and frequently hostile Indians. Geophysical studies and aerophotographic surveys are needed, and may well disclose many structures hidden by the forests east of the mountains.

The present oil production of Colombia comes from the Middle Magdalena valley, De Mares and Yondo concessions; the Barco concession on the Venezuelan border and the recently discovered Dificil field on the Caribbean coast. Important developments are taking place in new prospective fields such as the Cantagllo concession, and the Floresanto concession in the Sinu valley south of Monteria, where shallow production could be expected.

Although recent activity in Colombia was concentrated in the Magdalena valley, undoubtedly other and larger areas have even better possibilities. The areas of future prospects are: The Llanos of eastern Colombia adjoining the Venezuelan Llanos to the north where the rate of oil discovery has been high; the northern coastal area, which includes the lower Magdalena valley, the lower Cesar valley and the lower San Jorge and Sinu Valleys; also the extensive Pacific coastal belt, which to date has never been tested and where the geological conditions are

undoubtedly favorable for oil accumulation. Some authors claim possibilities for the strato valley on the Colombian Pacific Coast, but this valley is definitely less favorable than the rest of the Pacific Coast to the south. The development of all these areas will take many years, but at present they constitute an important reserve of future production.

Venezuela is the greatest oil producing country in South America and the third largest in the world. There are 22 major producing fields, of which 15 are located in the western part of the country, in the Provinces of Falcon and Zulia in the Maracaibo Lake region. The others are in the Provinces of Anzoategui and Monogas; over 70% of the production comes from the Lake-Basin fields. The producing formations are Upper Cretaceous and Tertiary. The average depths of producing wells is 3000 feet, though in the eastern Llanos there is one 10,000 feet deep.

Numerous wildcat wells have recently been drilled in eastern Venezuela, and some of the new areas promise to develop into substantial oil fields.

The following are the prospective areas of Colombia that may hold future reserves: the foothills of the Perija range on the western side of the Maracaibo-Lake Basin; Barinas area at the foot of the Cordillera de Merida, where the great thickness of Miocene sediments would require deep drilling; Guarico area, where wild-catting is presently very active; and the eastern provinces, including the regions of the Llanos bordering Colombia. Besides structural accumulations such as would be found along the mountain fronts, extensive stratigraphic traps could be expected in the vast southern Llanos of eastern Venezuela.

To recapitulate, the geological outline of South American oil fields and prospective petroleum reserve areas lead to the following summary conclusions:

Substantial petroleum production is presently derived from 13 major geological, oil-bearing regions or provinces.

About 90% of South American production comes from Tertiary formations of Pliocene to Eocene age. With few exceptions, Cretaceous formations account for the balance.

The greater part of the source rocks are also of Tertiary age and are followed in importance by Cretaceous shales and limestones. Devonian sources account for only small accumulations in Bolivia.

Upper Paleozoic, Gondwana rocks seem to act only as reservoir formations in the areas of Devonian source rocks.

Structurally, the presently developed oil accumulations are controlled mainly by Mesozoic-Cenozoic foldings, and, as a secondary factor, by stratigraphic traps.

With the exception of a few latest discoveries, practically all the oil fields were discovered by surface geological methods. Almost all the fields are located on Tertiary strata.

Further reserves can be expected along the Andean front ranges, in the thick and widespread Tertiary formations affected by late Andean foldings, and in many instances in stratigraphic traps against the shallow shield areas east of the Andes: also, in the Tertiary coastal plains along the coasts of Ecuador and Colombia. But until these vast continental areas, with favorable stratigraphic and structural conditions, have been adequately tested, no final estimate of the petroleum reserves of South America can be made.

All photographs on these pages are by S. E. Lane of Seismograph Service Corp.

Bank of seven amplifiers—not a totem pole.

Seismograph recording crew on the way to work.

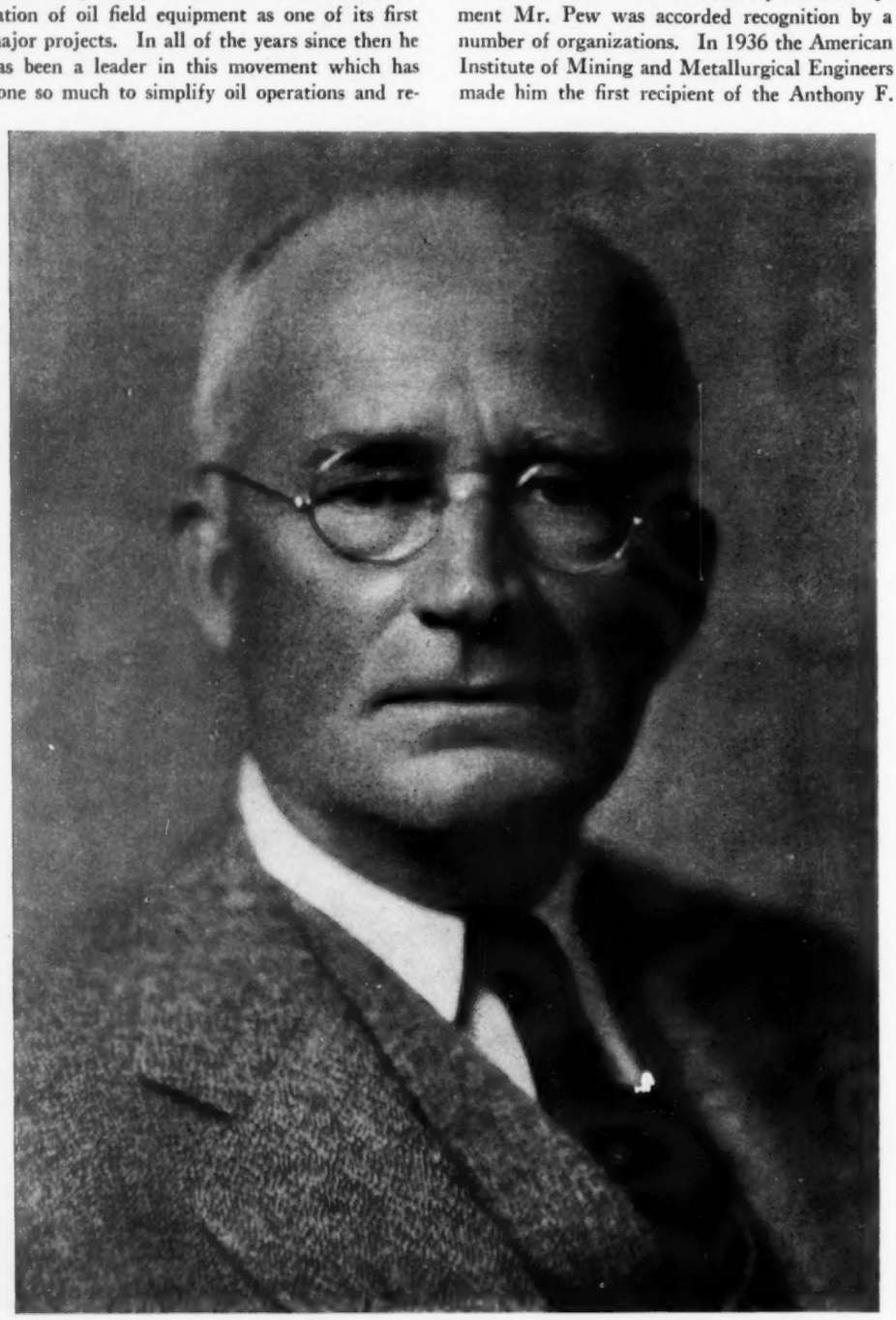
It's difficult to keep clothing dry in the South American tropics.

J. EDGAR PEW.... 1870-1946

J. Edgar Pew, for many years vice president in charge of production and pipe line transportation for the Sun Oil Company, Philadelphia, died on Nov. 22. He was 76 years old. He devoted 60 of his 76 years to the oil industry and was active in his company and in industry councils up to the time of his death.

Mr. Pew was the second president of the American Petroleum Institute in the formative days of that body twenty years ago. He was responsible for the adoption by the Institute of the standardization of oil field equipment as one of its first major projects. In all of the years since then he has been a leader in this movement which has done so much to simplify oil operations and reduce equipment costs. He was chairman of the Institute's general committee on standardization at the time of his death and only recently resigned as chairman of the Institute's committee on reserves which he had headed since 1935. In 1945 he was selected as the oil industry's spokesman to present data on American Petroleum reserves to the United States Senate Petroleum Investigating Committee.

For his work on standardization and promotion of scientific methods of oil discovery and development Mr. Pew was accorded recognition by a number of organizations. In 1936 the American Institute of Mining and Metallurgical Engineers made him the first recipient of the Anthony F. Lucas gold medal for distinguished service to the petroleum industry. The Texas Mid-Continent Oil & Gas Association gave him its distinguished service award for his leadership in the development of the Texas oil industry.



J. Edgar Pew

At the age of 16 he took his first regular job as a plumber's helper with the People Natural Gas Company at Pittsburgh. This company as well as Sun had been founded by his uncle, Joseph Newton Pew, Sr. He joined Sun in 1896 at Toledo, Ohio, where the company's first refinery had been acquired the year before.

In 1901 J. Edgar Pew was sent to Beaumont, Texas, to lay the foundation for the oil producing and pipeline operations of the Sun company. In 1901 the company built a refinery at Marcus Hook, Pa., and Mr. Pew continued his work in Texas to meet the requirements of this refinery until early in 1913, when he resigned to become an independent producer in Tulsa.

In December of that year he joined the Carter Oil Company as vice president and western manager, and continued with Carter in Tulsa until 1919, when he resigned and returned to Sun as vice president, and as president of the subsidiary Sun Pipe Line Company of Texas, at Beaumont. Since January, 1930, he has made his headquarters at the main office of Sun at Philadelphia.

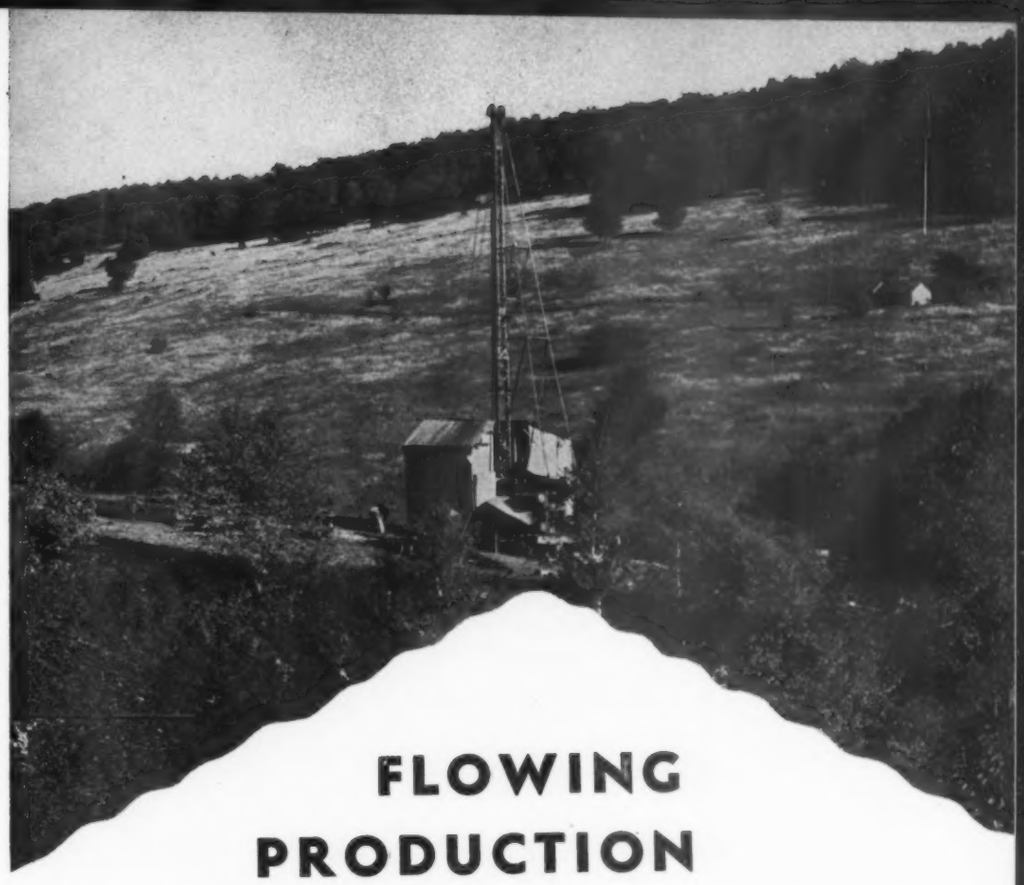
Mr. Pew is survived by his widow and three children, John G. Pew, Dallas; George L. Pew, Boston; and Mrs. Martha Elizabeth White, Dallas.

Mr. Pew was a brother of John G. Pew, president of the Sun Shipbuilding & Dry Dock Company, of Chester, Pa., Miss Eva Pew, of Chester, and Mrs. Jessie Lockhard, of Beaumont, Texas; and a first cousin of J. Howard Pew, president of the Sun Oil Company, and J. N. Pew, Jr., vice president of the Sun Oil Company.

Three days after Mr. Pew's death Sun Oil Company suffered a second loss in its official family. Frank Cross, secretary-treasurer and a director of the company, died November 25 after having been ill for about a month. He also was 76.

Mr. Cross had been with Sun Oil Company for 48 years, having started as a bookkeeper in the company's Pittsburgh office in 1898. He became secretary and a director in 1901. He became treasurer in 1904.

His widow, the former Margaret McKee, and three daughters, Mrs. Elizabeth Weidman, Hartford, Conn.; Mrs. William Wannamaker, Flourtown, Pa., and Miss Katherine Cross, Merchantville, N. J., survive.



FLOWING PRODUCTION IN SECONDARY RECOVERY

By DR. O. W. WILLCOX
Technical Editor

THE course of the oil industry since the middle of 1945 has been somewhat surprising. During the war the industry was bending every effort toward meeting the colossal military demands for petroleum products. Marginal oil wells that ordinarily would have been abandoned were kept in production by subsidies because even their feeble contributions were too important to be missed.

The general expectation was that when the war was over the enormous military demand would cease and peace would bring a decrease in the consumption and, therefore, a decrease in production of oil. Naturally, it was expected that the stripper fields that were being operated on a narrow margin of profit would lose their importance. But whether or not these fields remain in operation it now is evident that they still constitute a needed resource. The expected large drop in the post-war demand for oil has not been as great as was anticipated. According to statements issued from the Bureau of Mines, production during the first six months of 1946 was only 23 million barrels less than in the first six months of 1945, a decrease of only three percent. Evidently, the United States still needs oil in larger volume than in pre-war time. If current estimates of future needs are to be trusted the requirements for petroleum in the United States will continue to grow, and ten years hence —in 1956—will exceed 5,800,000 barrels daily, which would mean an increase of a million barrels per day over the present rate of production.

In view of this expected growth the petroleum industry is making great efforts to find the oil reserves needed to meet the coming demand. Oil companies are expanding their exploring and research operations. The search for new oil is being extended to the Continental Shelf, and new devices and equipment are being developed for drilling to greater and greater depths. There is much need for the industry to bestir itself in these directions; the task of finding more than a billion and a half barrels of new oil to meet the expectations of the prognosticators of near-future demand is a large one; the task will doubtless be accomplished, but the outcome is not assured.

While the industry has the finding of virgin oil fields as its main objective it is paying more and more attention to getting the most from the fields already opened. In the normal course of the life of an oil well there comes a time when it has passed the peak of its production and becomes a "stripper" well that yields a few barrels of pumped oil a day, and at length does not yield enough to pay the cost of pumping. According to Bureau of Mines figures, out of six million acres where oil has been discovered and produced, 3¼ million acres have passed the peak: about 300,000 of the 412,000 producing oil wells in the United States are in the stripper class. It is known that if these strippers are cleaned out and otherwise reconditioned they may be rejuvenated and kept in profitable production for several years longer. Without effective rejuvenation some nine or ten thousand of these wells will be abandoned every year, and the by no means negligible quantities of oil still in their reservoirs will be lost.

During the war the production of oil from stripper wells was encouraged by subsidies. These subsidies are being removed from the strippers are going "on their own." If their costs are more than the price of oil in a free market they must close down or reduce their costs by improving their methods, preferably by employing some form of secondary recovery.

Many of the oil fields of the stripper class are operated by small companies or individuals with small capital resources who could benefit greatly by making use of the engineers and laboratory research on secondary methods of oil recovery that have been accumulated during the past 25 years and particularly the work that has been done in Pennsylvania and more recently in the Mid-Continent. An excellent summary of this research and experience was given in a symposium on secondary recovery at the November, 1946, meeting of the American Petroleum Institute.

To repeat, with the subsidy on stripper production taken away, the stripper operator's main hope of survival is a reduction of his costs, and especially his pumping costs. His present situation seems to require that he give particularly earnest attention to the possibility of converting pumping wells into flowing wells on secondary recovery projects by flowing methods that have lately come into prominence in both water-floods and gas-repressuring projects.

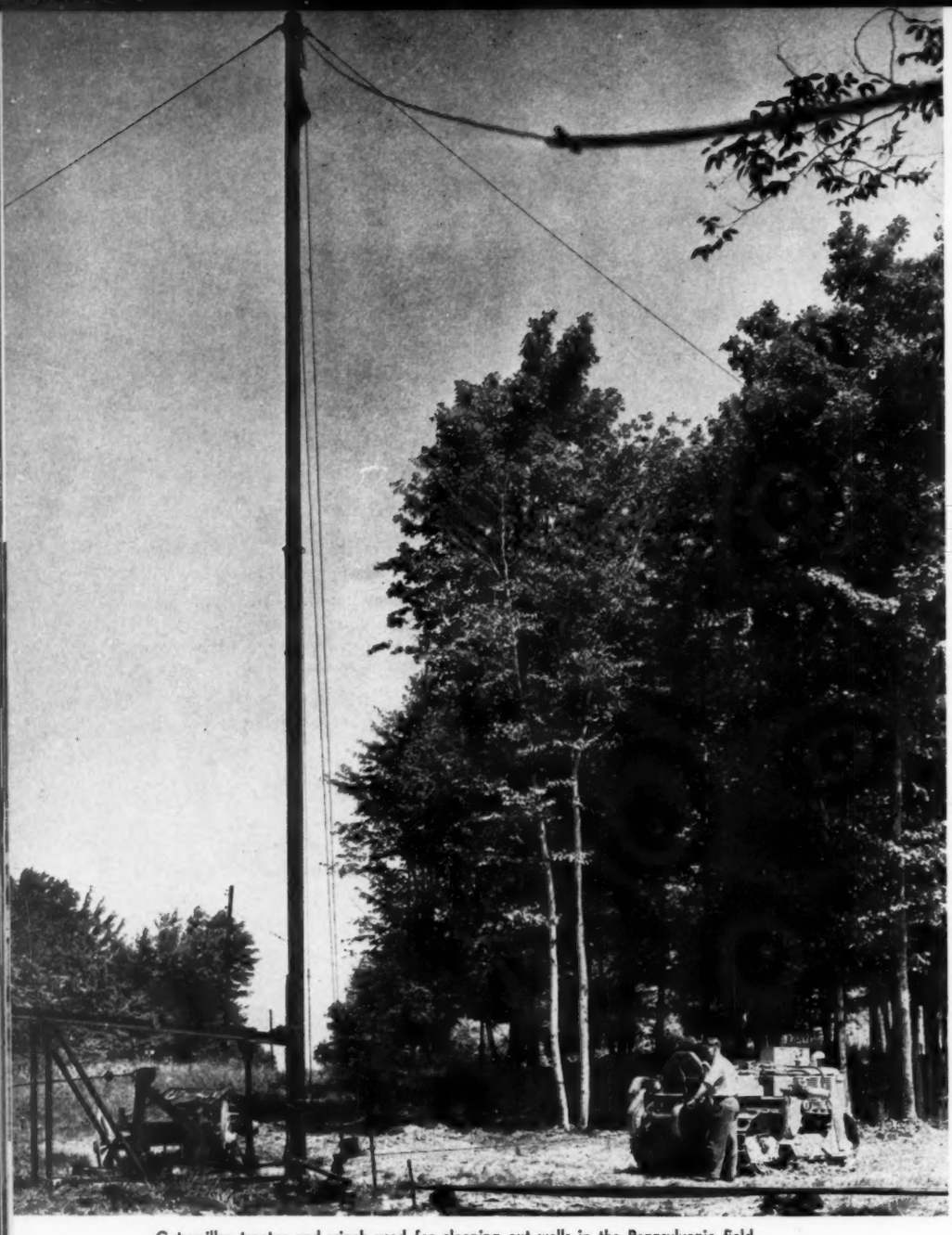
Recovery by Flowing Water-Floods

The original idea of secondary recovery was to pump water into the depleted oil sand in order to drive the residue of oil still contained in the reservoir to the bottoms of the well shafts where it could be taken up by the pumps. This method was first systematically developed in the Bradford area where the "five spot" system of spacing the wells for pumping in water and the wells for producing the oil was worked out. In the original Bradford system the pump was still a necessity. Later on there arose the idea of dispensing with the pump and using the input water to wash the oil not merely to the bottom of the hole, but on up to the top where the oil could easily be separated from the water.

The more evident advantages of flowing over pumping water-flood production are well known. In review, they are:

(1) The capital cost per oil well drilled and completed is less, due to absence of pumping equipment.

(2) The well produced by flowing virtually operates itself, due to absence of mechanical parts.



Caterpillar tractor and winch used for cleaning out wells in the Pennsylvania field.

Venango Development Corp. tried sinking a shaft and drilling horizontally as a secondary recovery method.

(3) Labor requirements in flowing are much smaller, as well-servicing crews, mechanics, power and rod-line gangs, are not necessary.

Some advantages of flowing over pumping which are not common to all flowing wells, but apply only in local, specific instances are:

(1) A flowing well can be completely inundated in a creek or river flood or its back waters, and suffer no damage unless a connection is broken by floating debris. Also, a flowing well may be purposely inundated in a lease pond, or pasture stock pond, and have no effect upon the water in any way; whereas it would be impossible to submerge a pumping unit without cleaning up the prime mover and flushing out the gear box after the flood had subsided. Even pumping wells on the jack that have been inundated or covered with flood water must be cleaned.

(2) The advantage of a flowing well over a pumping well is also great in rough terrain, in that the flowing well needs no servicing attention in its lifetime; and, consequently, after the well has been drilled, no further thought of lease roads into the well need be given the flowing well. This is especialy true in wet weather when roads become impassable for a pulling unit.

(3) Operators of both flowing and pumping wells assert that oil produced by flowing is much easier and simpler to put in condition to sell to the crude-oil purchaser than pumped oil.

Practically all the fields in which water-flood oil wells are now produced by flowing are located in the Mid-Continent region which comprises eastern Kansas, northeastern Oklahoma, and north Texas. There are several reasons why flowing is largely restricted to this area:

(1) Most of the pay sands are of shallow depth.
(2) The sands have, for the most part, good permeability to water.
(3) The sands being water-flooded are not so prolific that any economies which may be effected can be overlooked.

The history of flowing water-flood production in the Mid-Continent is similar to that of almost all techniques in the petroleum industry. It began an as experiment at a time when the lease on which it was tried had declined in oil production and gained in water production, until the latter was almost predominant. At first the operators were skeptical as to the advisability of abandoning pumping in favor of flowing. It appeared that flowing was apparently getting only half of the oil that could be obtained by pumping. On the other hand, the cost of pumping the oil was greater than the price that could be gotten for it. However, since pumping could not be continued except at a loss, the well would have to be abandoned, whereas by flowing some oil, even if it was smaller in daily amount, could still be obtained at a profit. When all factors were put together, it was seen that it was pos-

sible to deplete the lease much more thoroughly by flowing than by pumping because higher water-oil ratios can be handled by flowing.

After the conversion to flowing, the daily production fell off, but the lease costs by flowing were so much less than they were by pumping that it was possible to operate the lease at an even smaller rate of production and still make money. In the 48 months since one lease discussed at the Chicago A.P.I. meeting was converted from uneconomical pumping to profitable flowing, it has recovered for its owners an additional several hundred barrels of oil per acre that would otherwise have been lost in premature abandonment of the pumping project.

As a matter of history, flowing was first attempted in water-flood operations in the Bradford field in Pennsylvania, and the Bradford operators have been experimenting with it ever since. Such experiments appear to have been successful in only one instance where production by flowing compared favorably with surrounding leases that were produced by pumping. The reason for the general lack of success of flowing in the Bradford area is ascribed to the low average permeability of the producing sand in Bradford where it has always been necessary to use maximum pressures in the flowing operation. A number of these experimental wells were seriously damaged by irruption of the water into overlying strata due to pressures that were too high for the overburden to support.

One of the lessons of this bit of petroleum history is that oil production by flowing of water floods is most likely to be satisfactory where the sand permeability is good. Of course, the advantage of good permeability will be offset if the viscosity of the crude oil is high.

Flowing in water-flood operations is beset with various reasons for failure. One of the primary reasons for trouble results from gas sands exposed in either or both the injection well and the oil well. If the gas sand is exposed in the oil well, but not in the injection well, the very serious possibility of back-flooding oil into the gas sand in the oil well is present. If the gas sand is exposed in both injection and producing well the result will be disappointing—whether the production is pumped or flowed—because too much of the available energy will be uselessly bypassed through the barren sand. Too often the presence of the thief zone is found after many wells have been drilled and completed. The value of preliminary core-testing the proposed area to be developed is especially evident if troublesome spots are detected and eliminated before the misfortune has occurred.

Flowing met with disfavor in a shallow water flood in eastern Illinois when a shale bed or series of shale beds in the producing zone broke down and caused serious, permanent channeling of injection water. The breakthrough here is also ascribed to excessive injection pressure. The record does not show whether the possibilities of lower pressures were investigated in this field.

Besides sand permeability and crude oil viscosity, depth and spacing enter into the economics of flowing vs. pumping. At a depth of 1,000 ft., low permeability is a much less troublesome characteristic than it is at 500-ft. depth, because greater injection pressure can be used at the former depth to overcome the limitation imposed by low permeability. The same holds true for high crude-oil viscosity at greater depth. On the other hand, at a 1,000-ft. depth the close spacing usually employed at a 500-ft. depth would involve considerably greater development cost per acre; therefore, wider spacing would be a choice. At wider spacing, some of the advantage of depth as mentioned previously, will be lost with the smaller number of injection wells employed at greater depth. Therefore, a much more satisfactory procedure for an operator to follow, in attempting to fit his new water-flood project into the picture of pumping vs. flowing, is to depend upon an engineering report by someone with a fund of experience rather than to attempt to consult a permeability-viscosity table to answer the question of whether his water-flood production should be pumped or flowed.

Some water floods in eastern Kansas are being flowed successfully at depths of 500 ft. and greater, in which the crude-oil viscosity is 25 centipoises at reservoir temperature and permeability is as low as 30 millidarcys. Some experts are inclined to regard these figures—permeability of 30 millidarcys and viscosity of 25 centipoises—as lower limits for satisfactory operation.

Besides the above, other considerations of large importance enter into the economics of flowing from the engineering point of view. Among these are the use of old wells for input and/or output as compared with the drilling of new holes; methods of completion of flowing oil wells; the choice of equipment, etc. Concerning these, the inexperienced operator interested in the flowing of water-floods will do well to avail himself of the services of experienced advisers.

Flowing Under Gas-Pressure

In water-floods the resudual oil in the sand is driven to the well by the pressure of injected water. Another well known method of creating this pressure is to inject air, or preferably gas, into the sands that have ceased to flow naturally. As in water-floods, the traditional practice in secondary recovery projects by gas pressure has been to lift the oil by pumping.

Pumping a stripper well that is being depleted by gas injection is open to the same objection that applies to analagous water-flood projects—the relatively large cost of the pumping operation. The tendency now is to flow water-drive projects wherever possible, and thus save most of this expense. Recently the idea of doing away with the pump in gas-floods has been receiving serious attention. This idea has the following basis: in a gas-flood project, gas under high pressure is compressed into the stripper field in order to drive the oil into the produing wells; would it not be possible to devise strings of small tubing to use part of this energy to flow the oil to the surface instead of pumping it?

Work on this problem dates at least as far back as 1928, when Lawrence E. Smith showed that by restoring gas pressure in an old Texas field the oil could be made to flow regularly. About 2½ years ago operators in the Oil City field, assisted by the Bureau of Mines, took up the idea, and found that by means of specially designed strings of tubing it was possible to apply the method to wells that were producing as little as 0.1 bbl. of oil a day, and from depths exceeding 1100 feet. First mention of this later work was made in brief articles published in 1944, and since that time several operators have experimented with the idea. At the present writing, some 77 wells producing from the Venango sands in Pennsylvania have been equipped with flowstrings on 18 air injection projects.

Full details on this work have not yet been published, except that 1-inch siphon-type flowstrings are satisfactorily flowing 0.1 to 2.5 bbl. of liquid (oil and water) daily from wells 700 to 1000 feet deep at gas-liquid ratios up to about 8000 cu. ft. or more in some cases. For higher gas-liquid ratios intermittent flow can be achieved by strings of larger diameter. Wells flowing at gas-liquid ratios below 5000 cu. ft. perform most satisfactorily and require the least attention.

According to Grant and Bossler,* the type of flow-string shown in the accompanying diagram is the most widely applicable in the Venango area. It consists of a 1″ flowstring inside a 2″ tubing. A 2″ x 6″ anchor packing is set below the lowest non-productive "thief" sand and above the two pay sands. Fluid inlet slats are milled in the bottom joint of the flowstring at short distances from its capped end, and slits are made in the 2 inch tubing opposite the two producing sands. The whole assembly is similar in design to the commonly used gas-well siphon.

Data comparing oil-, water-, and gas-production rates before and after converting these projects from pumping to flowing are available for individual wells on only a few leases. Oil-producing rates of a few wells have been slightly less by flowing than when pumping, while oil-production rates of the other wells have been either unchanged or increased by flowing. Marked decreases in produced gas-liquid ratios as a result of flowing were noted where comparative data were available. At present these indicated results cannot be applied beyond the boundaries of the leases on which they were obtained, but they do provide the incentive for further experimental work.

On one project continuous production records have been kept for a 20-month period on a group of 16 flowing wells. During the 20 months only

* Producers' Monthly, July ,1946.

four pulling jobs have been necessary to repair or change flowstrings in the 16 wells, and this is a marked reduction in well pulling expense.

During the course of experimentation, failures have occurred, and several problems have arisen. For example, wells have failed to flow when the shut-in pressure was insufficient for flow and it was inadvisable to increase the pressure on offsetting injection wells, or where irregular operation of injection wells precluded the possibility of increasing the average sand pressure. Some of the problems that have developed in operating flowing wells are:

(1) The control of badly "channeled" producing wells having excessive gas-fluid ratios.
(2) The creation of water-in-oil emulsion in flowing the more viscous crude oils.
(3) The formation of paraffin deposits in the flowstring.
(4) The need for occasional air-lifting to kick off "dead" wells.

Although neither paraffin nor emulsion have proved serious so far, the extent to which they would affect wells in other areas is unknown.

If this method is to be applied successfully there must be stabilized injection to the sand through an adequate number of input wells so distributed that there will be no low-pressure areas in which wells will not flow, as no important reduction in operating costs can be expected if central compression equipment must be maintained for only a part of the producing wells on the lease.

Explosives in Secondary Recovery

All the experts who have discussed the subject of producing a secondary recovery project by flowing have stressed the importance of sand permeability as a factor of satisfactory operation.

Whether the aim is to deplete an old oil field by a water-flood and pump, or by a flowing water-flood, in almost all secondary-recovery developments where oil production is obtained from sandstone formations, it is common practice to shoot the pay strata in both the injection and production wells with nitroglycerine. It is believed that the effect of the shot is not only to clean the sand face in the well bore but also to cause radial fractures from the well into the sand body and thus permit a more rapid flow of fluid from the sandstone into the well or of water into the formation, whichever the case may be. Field data and numerous tests substantiate the fact that, in cases where shooting does greatly increase the productivity of a producer or the injectivity of an input well, the result obtained must be by way of radial fractures and not by increase of hole size alone. In effect, however, these fractures appear to give the same result as an increase in hole diameter to as much as 50 ft.

Numerous field tests in the Bradford field and the shallow fields of northeastern Oklahoma and eastern Kansas have shown that good injection rates for water flooding can be obtained by shooting, whereas without shooting the rates will be very low, and certainly far too slow for economic flooding. At the same time it can be said that the need for shooting and the size of the shot may depend on any one or all of the following: permeability, depth, and characteristics of the sandstone itself.

If permeability of the sand is low as in Bradford, shooting—and heavy shooting at that—is necessary. At the present time water flooding is being carried on in some localities—especially North Central Texas, where shooting of even shallow sands is not employed because of the fact that the permeability is so high (500 to 2,000 millidarcys)—that inputs will take sufficient volumes of water without shooting. In such cases it is probable that shooting will not be necessary for other than the purpose of selective shooting.

This latter operation consists of shooting heavily the sand of lowest permeability and that of higher or highest permeability lighter, or not at all, in order to even the water-front travel from the well into the vertical sand section. Selective shooting based on individual well cores has now been in use on a rather wide scale by many operators for six to eight years. In most cases where it has been used, it has proved advantageous in increasing economic oil recovery and at the same time reducing overall "water-injection to produced-oil" ratios. Increase in oil recovery, of course, results in increased gross income, whereas reduction in "injected-water to produced-oil ratios" results in reduced operating costs. In planning a selective shot, however, the factor of oil and water saturation must be considered in addition to permeability. This is especially true in old fields where there are a number of old abandoned wells, any one of which may have been a leaker resulting in accidental water drives in certain areas under a lease.

The effect of a shot in different wells apparently depends to a large extent upon the physical characteristics of the sandstone itself. In a paper presented at the November meeting of the API, R. C. Earlougher exemplifies this by comparing shooting in the Bradford area and in the shallow sand areas of Oklahoma and Kansas. The Bradford sand is very hard, tight, and dense; whereas the Bartlesville sand in the shallow fields of the Mid-Continent is somewhat coarser and a little softer. Apparently, as a result of this difference, shot concentrations in the Mid-Continent of about twice the size used in Bradford are necessary in order to obtain the same increase in water-injection rates. For example, a sand in Bradford having an average permeability of 10 millidarcys might be shot using a concentration of 2.5 quarts of glycerin per foot to obtain a five-fold increase in injection rate; whereas a sand of the same permeability in eastern Kansas would require a concentration of four quarts per foot to obtain a similar increase. Likewise, it has been found that some of the deeper Bartlesville sand in the Mid-Continent will take little more water after shot than without shot, especially in areas where the sand is cleaner, with smaller amounts of shale in the cementing material—and, although quite hard, at the same time of a crumbly nature. One operator in southeastern Kansas, flooding Bartlesville sand at a depth of approximately 1,000 ft. reports that injection wells not shot seem to take water as readily under 800 psi surface pump pressure as those wells which were shot. Similar results have been reported from east central Kansas where Bartlesville sand is being flooded at depths varying from 1,800 ft. to 2,800 ft. There are two possible explanations for these results. The first is that, because of the greater depths, higher bottom-hole injection pressures can be used to obtain the desired injection rate. The second is that it may be the sandstone in these cases shatters and crumbles when shot, rather than fracturing radially outwards from the well bore. In by far the majority of cases, however, in the more shallow flooding operations in the Mid-Continent area it has been rather amply proved that shooting is not only desirable but necessary, if satisfactory injection rates are to be obtained.

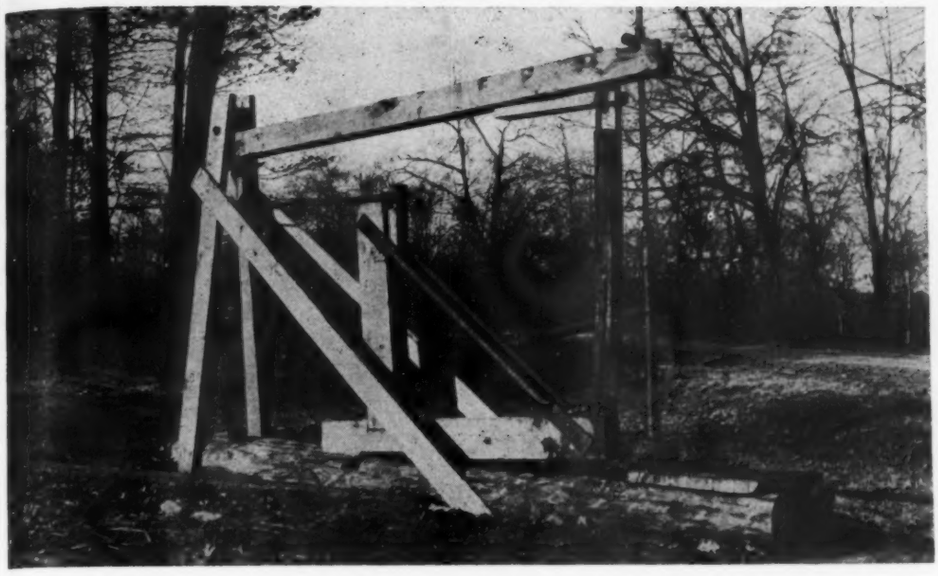
Plugging Agents in Water-Flooding

The purpose of selective shooting as discussed above is to increase the permeability of tight sands so as to facilitate the passage of water and oil through them. It may be regarded as a means of equalizing the permeability of different zones. Equalization, or control, of permeability in secondary recovery, is often necessary for another reason.

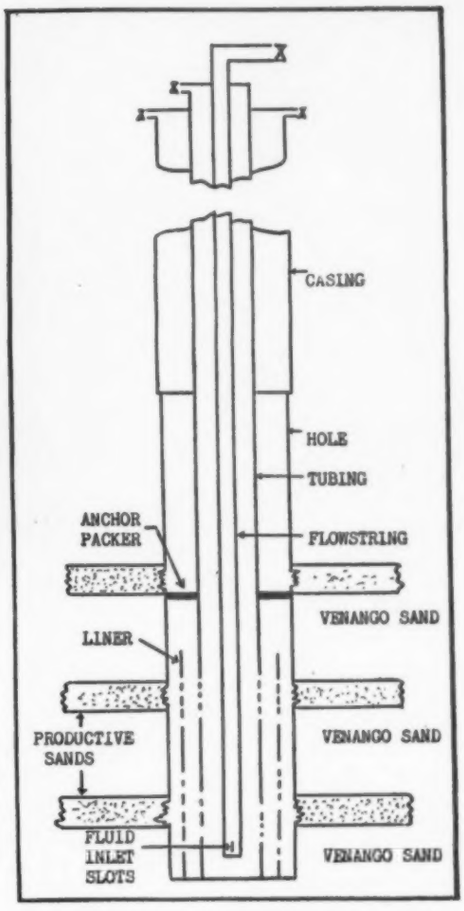
Strata of high permeability are responsible for large flush production when wells are first completed. When it becomes necessary to apply water or gas drive, they are quickly flushed out, and thereafter become a liability by short-circuiting the flow system. Because of their high permeability, and because the driving fluid has low viscosity relative to the oil, the greater part of the energy expended in pumping the fluid may be wasted. At the same time tight strata, delivering oil to the producing well, are receiving but a small portion of the injection fluid pumped, perhaps at pressures too low for efficient displacement, because of the excessive total fluid required by the injection well. The net result of this situation is that recovery operations become uneconomic long before all of the layers which make up the reservoir have been subjected to the sweeping action of the driving fluid.

It has been necessary, therefore, to find means of reducing the permeability of the loose strata without appreciably affecting the flow into the tighter streaks. This is accomplished by suspending a finely powdered substance in the injection water. Experience has shown that the looser sands take relatively more of such a suspension and consequently, more of the plugging particles.

Among plugging materials that have lately been tried with varying success are bentonite, Portland cement, talc, whiting, zinc oxide, silica gel and

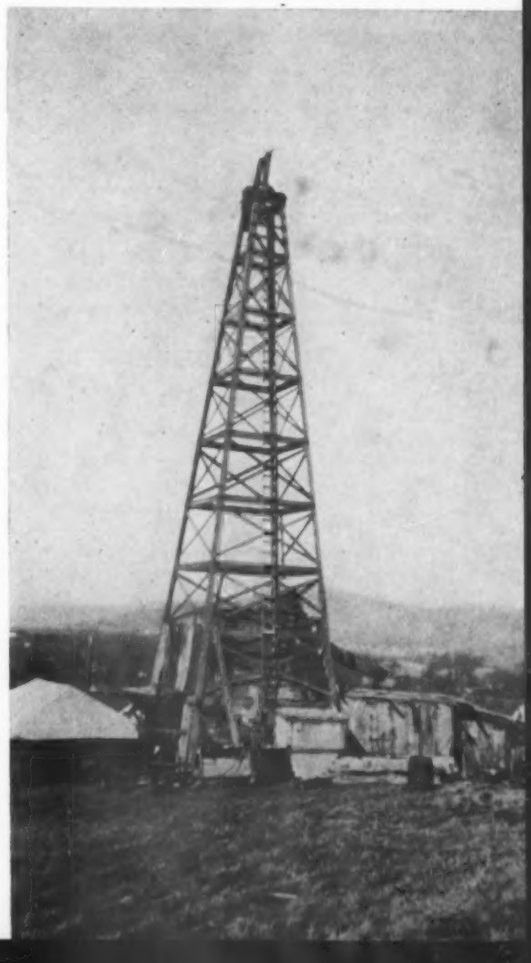


Producers of low volume wells must keep costs low in equipping them for pumping.



Flowstring for flowing oil well under pressure in secondary recovery.

Wooden derrick in Western Pennsylvania. Photographs with this article supplied through courtesy of Pennsylvania Grade Crude Oil Association.



similar substances which are not too coarse to enter the sands of which the permeability is to be reduced. For the tight sands of Pennsylvania where the plugging particles should be quite small, it has been found that colloidal dispersions of wax, properly stabilized with dispersion agents, are particularly effective. Here again it is the relatively coarse sands that take most of the plugging material and suffer the greatest proportional reduction in permeability. The resulting plugging action decreases the water-oil ratio, increases the input water pressure, and in most cases increases oil production.

Conclusions

The flowing of oil in secondary recovery projects by artificial water or gas-drive offers an attractive means of doing away with the pump and thus lowering the cost of operating such projects. In water-floods there is the added advantage of a more thorough depletion of the reservoir than is possible by the traditional method of pumping. The flowing of gas-drive projects has been successful in Pennsylvania fields with wells that yield as little as 0.1 barrel of oil a day. The practical use of this method in other than the Venango sands remains to be proved, though the prospects seem good.

There seems to be little doubt that the flowing of oil wells in secondary recovery is practicable wherever two dominant factors are favorable. These are the permeability of the oil sand and the viscosity of the crude oil. The minimum values of these factors are supposed to be, respectively, 30 millidarcys and 25 centipoises. These minima are not necessarily fixed, and in some cases may be lowered, especially in wells of 500 or more feet in depth, which will allow application of higher pressures than are admissible at shallower depths.

The question has been raised as to why use pumps for lifting oil if the oil can be produced by flowing under artificial drive? The idea here is that every oil field is a candidate (so to speak) for secondary recovery when its period of natural flow is over. If the field has the characteristics that would fit it for application of secondary recovery, why keep it on the pump until the cost of pumping is prohibitive, and then resort to artificial drive? A lot of pumping cost would be saved if secondary recovery were instituted as soon as natural flow ceased; the same could be said of virgin fields that have no natural drive to begin with. The suggestion here is that new drilling in proven fields should be executed in view of eventual depletion by some form of artificial drive, and that cores and other sources of information that bear on the question of secondary recovery be collected while the well is being drilled. If this is done all arrangements for secondary recovery could be made ready when the time for it has arrived.

Papers On Secondary Recovery

The following papers presented as a symposium on secondary recovery at the November 1946 meeting of the API will be of interest in this connection:

Utilization of Old Wells—W. A. Heath, Earlougher Engineering, Tulsa, Okla.

Use of Explosives in Secondary Recovery—R. C. Earlougher, Earlougher Engineering, Tulsa, Okla.

Source and Purification of Gas Supply—L. L. McWilliams, Phillips Petroleum Co., Bartlesville, Okla.

Distributing Systems and Surface Injection Equipment—C. H. Keplinger, Keplinger and Wanenmacher, Tulsa, Okla.

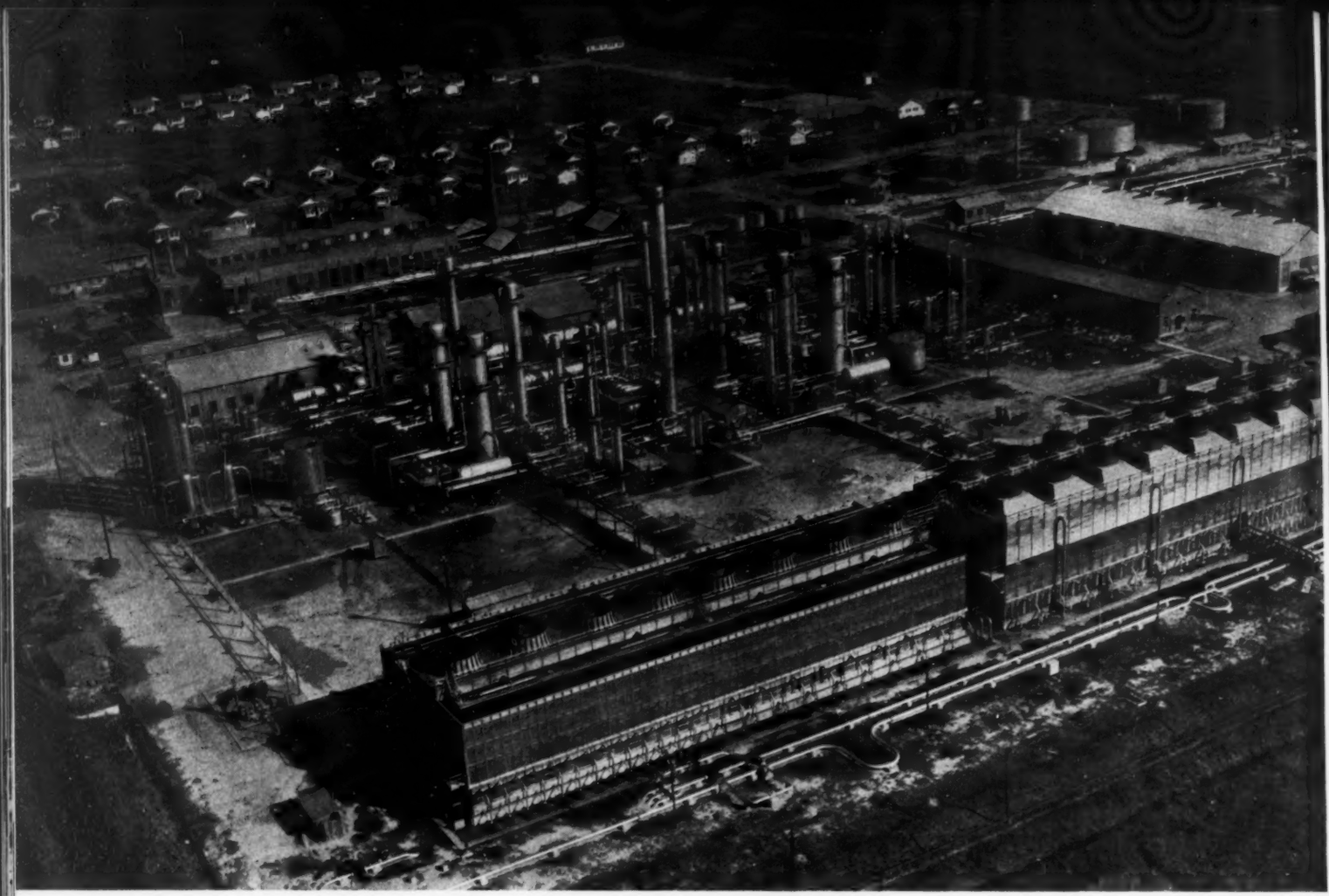
Pumping-Equipment Selection for Secondary Recovery Developments—Emory N. Kemler, Southern Research Institute, Birmingham, Ala.

Separators and Tanks—W. L. McCloy, Jr., The Standard Oil Co. (Ohio), Cleveland, Ohio.

Flowing Water-Flood Production—T. F. Lawry, The Ohio Oil Co., Eureka, Kans.

The Use of Plugging Agents—H. T. Kennedy, Gulf Research and Development Co., Pittsburgh, Pa.

A Review of Five Years of Operation of the Langlie Unitized Repressuring Project—Ralph L. Gray, Stanolind Oil and Gas Co., Hobbs, N. M.



General view of Katy cycling plant near Houston.

CORROSION AND PREVENTIVE METHODS IN THE KATY FIELD . . .

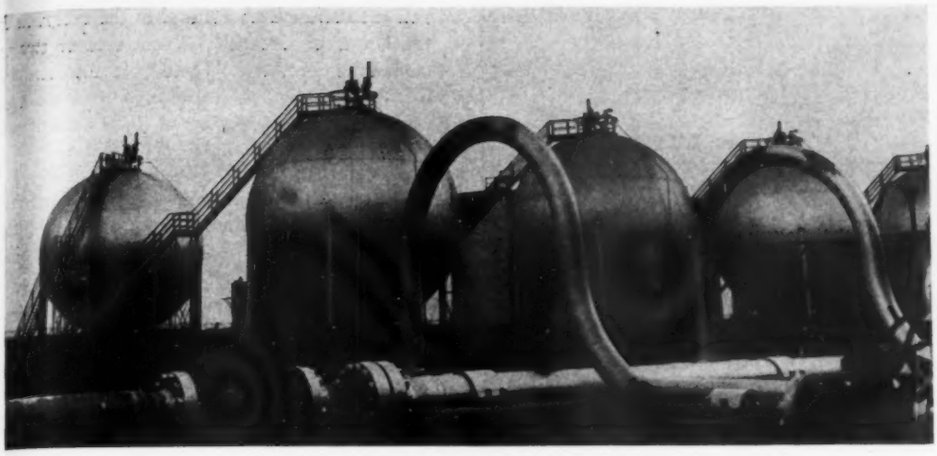
SUBSTANTIAL progress in the control of subsurface and well-head corrosion in the huge Katy gas field near Houston was reported to the recent meeting of the American Petroleum Institute in a paper by R. C. Buchan of Humble Oil and Refining Co. Although long periods of research still are in prospect because of the numerous variables he reported that "a reasonably early solution of the problem in that field appears likely."

Corrosion is a problem at most, if not all, of the 32 cycling plants in Texas which are processing approximately two billion cubic feet of gas and recovering 50,000 barrels per day of total products. Experience has shown that corrosion may be expected in condensate wells having pressures above about 1500 psi and reservoir temperatures above. 160°F. if the gas contains CO_2 in excess of about 0.2 percent by volume. Unfortunately, the research program undertaken under sponsorship of the American Petroleum Institute, the Natural Gasoline Association of America and the National Association of Corrosion Engineers does not yet indicate any general measures which can be applied at all plants with equal success. It appears that each field must be studied separately since the conditions aggravating corrosion may vary with operating temperatures and pressures, production rates, and the characteristics of the produced gas and water. Following are excerpts from Mr. Buchan's report to the API on specific problems at Katy.

"Corrosion affects to some extent all casing and tubing strings subjected to well fluids. The ferrous surface equipment, including well-head assemblies, meter runs, and the gathering system, are corroding internally. Corrosion in the plant has been negligible; and, although conditions warrant periodic inspections, corrosion is a minor problem at present, and it is believed that it will not become serious. The casing is believed to be corroding externally as a result of battery currents between the casing and flow lines. These currents are believed to have no effect on internal corrosion; however, insulating flanges are to be installed to minimize external casing corrosion. The corrosion of subsurface equipment is the most expensive part of the overall problem.

"The internal corrosion of ferrous equipment of Katy in due to the acidic properties of the condensed water under the existing pressure and temperature conditions . . . Carbon dioxide and organic acids are present. No doubt other substances are present, some of which probably increase whereas some decrease, the corrosion rate; but the effect of no single substance has been isolated. The produced gas contains 0.6 to 0.7 percent carbon dioxide. The condensed water at the plant inlet contains 390 to 400 parts per million of organic acids (as propionic acid), and about 150 parts per million of iron. The pH of the water in the tubing has not been measured because of physical difficulties, but it is believed to be about four.

"Thorough studies of data from individual wells have not resulted in determining the effect of the several variables involved. The iron content of waters taken at individual wells varies



Butane storage tanks at Katy cycling plant.

considerably, i.e., from 70 to more than 400 parts per million; and, in general, the iron content appears to be lower in many wells at high rates of flow than at low rates. All evidence to date indicates that no iron or not more than a trace of iron is produced from the formation. Only one well in the field is producing more than a trace of salt water, and it has been under specific observation only a short while. The organic-acid content is fairly constant. No rate of production in any well has eliminated internal corrosion of tubing.

"The estimated average annual loss due to corrosion in the Katy Field is $200,000. About 75 percent of this is for the periodic replacement of tubing, whereas the remainder is for inspecting and replacing other equipment. This estimate assumes that the casing has not been damaged sufficiently to cause early casing failures.

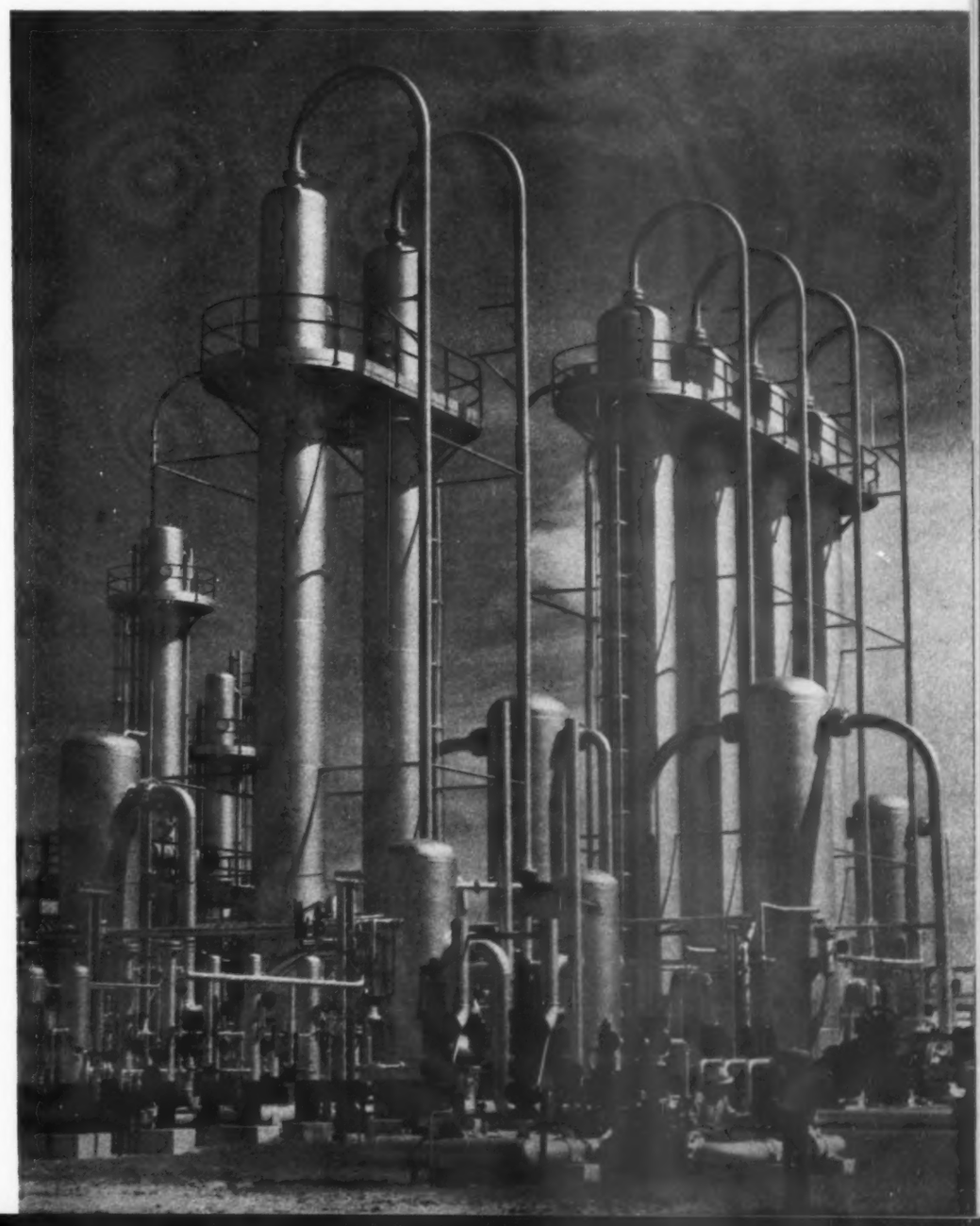
"Plastic coatings are not a proven product, but success to date indicates that they deserve careful consideration. At Katy, for example, all of the tubing in producing wells can be coated for about $140,000, or about the same amount as the estimated average annual workover expense due to tubing corrosion. Should the coatings extend the life of tubing only one year, they will pay out in comparison with using bare tubing and no corrosion. If plastic coatings will extend the average life of tubing 5 years, the use of coated pipe will probably prove to be the most satisfactory method of handling the subsurface problems. It would not solve the corrosion problem in entire well-head assemblies because of erosion in choke assemblies, nor does it eliminate the need for probable chemical protection in the gathering system. The best advantage that plastic-coated tubing has to offer is that the tubing can be packed off to obtain protection against casing failures while a reasonable protection against corrosion is obtained. The monetary value of this safety precaution is difficult to estimate at the present time.

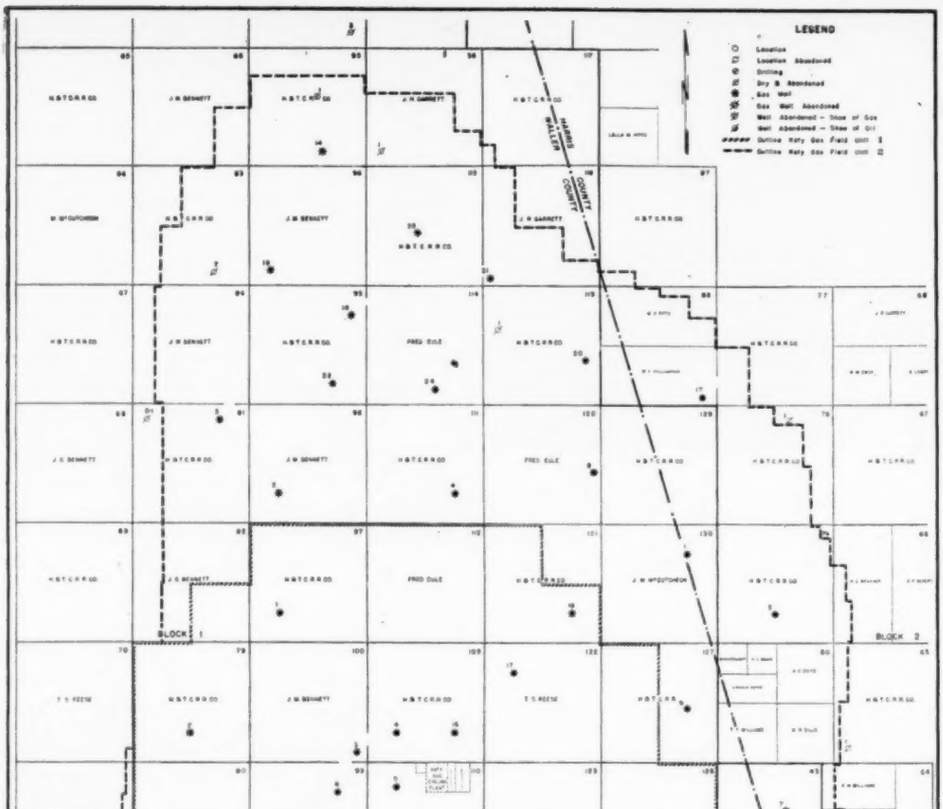
"The successful use to date of soda ash as a neutralizing agent makes it appear to be a practical solution to most of the problems in this field. The relatively small amount of neutralizing agent required could not have been predicted from laboratory tests two years ago. It is estimated that soda ash, when used in all wells, will reduce the average annual corrosion expense to about $50,000. Its principal disadvantages are: first, the need for constant attention and checking; and, second, the fact that either the casing or an additional string of tubing is needed to convey chemical to the lower part of the tubing. The chemical itself will cost about $8,000, whereas the remainder is chargeable to: 1, expense of applying; 2, checking results obtained; and 3, losses not prevented. Some type of chemical treatment appears desirable in the gathering system, and the soda ash injected for subsurface protection also fills this need.

"Other more expensive chemicals may prove as economical as soda ash—particularly if they are found and applied in those wells that at present are scheduled for workover jobs so as to postpone or eliminate those workover."

In his concluding remarks Mr. Buchan advised other operators of condensate plants to take corrosion into account when developing new fields early in the life of the field and stated that the newer tools such as caliper surveys and radium inspections allow rapid, accurate determinations to supplement visual inspections and water analyses. Early field trials of promising methods

Primary separators and battery of absorbers.





should be made rather than waiting for all questions to be answered by laboratory studies.

The Katy gas field, located about thirty miles northwest of Houston, lies principally in the extreme southeastern corner of Waller County with its outer limits extending into Harris and Fort Bend Counties. The field was discovered in 1935 but developed slowly because of the limited market for gas and because cycling operations had not progressed to a commercial stage at that time. It was later recognized that the field was one of the largest natural gas reserves in the United States, and by 1939 drilling had proceeded to the point where unitization of the properties seemed desirable, and negotiations were begun to effect cycling operations for the field. When the field was organized in 1941, it covered 11,285 acres. Further development revealed that the field has a total of about 30,000 acres.

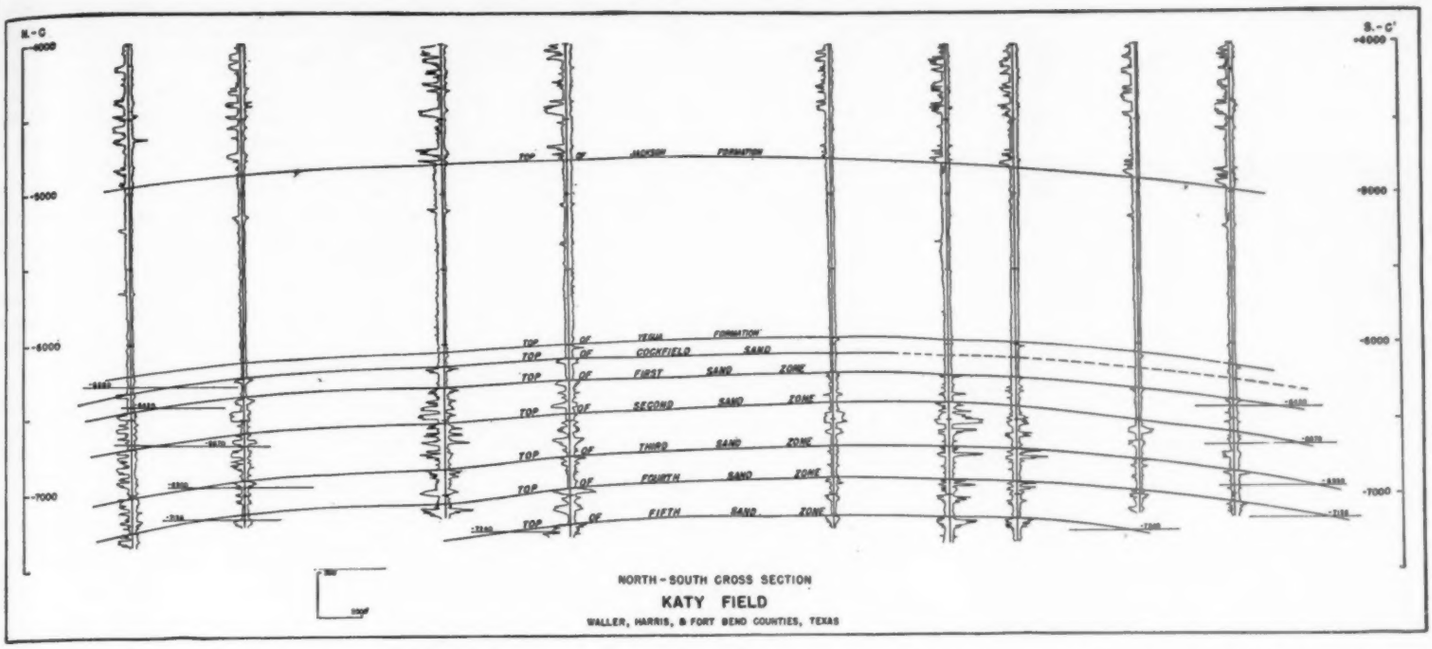
There are six separate sands in the huge dome which is unique in its extreme regularity and absence of faulting in an area where complex structural conditions are common. It has a known closure of approximately 300 feet, with the highest part of the structure apparently lying in the southern portion of the producing area, and having a long, flat structural nose extending northward. Gas-condensate production is obtained from the Yegua formation between the depths of 6,250 feet and 7,450 feet, a vertical stratigraphic section of approximately 1,200 feet. This section has been divided into six sands, and those in turn separated into one or more reservoir members. Each zone, with the exception of the Upper or Cockfield, is composed of two or more sand members. These sand members are locally lenticular and variable in thickness over the field, with porosity of 18 to 34 percent and a permeability range up to 1500 millidarcys.

Present cycling operations are confined essentially to the fourth gas zone with the fifth zone being produced to make up gas sales, fuel, and plant product shrinkage. The average reservoir pressure for the fourth zone is 3,150 psi and requires a pressure of 3,050 psi at the injection well for reinjection. Continuous studies are being carried on by the field reservoir engineer to correlate such operating data as reservoir pressures and temperatures, gasoline content of produced gas, and quantitative production and injection rates, in order to properly control the sweeping pattern of the injection gas. The basis for predicting the most desirable location for producing and injection wells, and also the production rates for such wells, is arrived at through potentiometric laboratory studies.

The first plant was built in 1942 to process 235 million cubic feet of wet gas daily from 15 wells and produce 7,500 barrels per day of liquid hydrocarbons, with the return of 185 million cubic feet of residue gas to the producing formation. Plant operations were begun in 1943 recovering mixed butanes, 250°F. end point gasoline and distillate.

Construction of the first unit was not completed before additional drilling revealed the field to be much larger than had been anticipated and a second unit covering 18,577 acres was organized. This unit was completed in October 1944. The two were tied together, however, and operated as a single plant by Humble Oil & Refining Company for the joint interest of the 35 owners. An Advisory Committee and Field Operators' Committee, with the aid of Geological and Engineering Sub-committees, assist Humble Oil & Refining Company with the development and operation of the project.

Wartime demand for iso-butane and special ethane-propane cuts for chemical manufacture dictated the erection of a fractionating unit at the plant to process the butane and lighter hydrocarbons for production of iso-butane, normal butane, and propane of 95 percent purities. Shipping and tank car loading facilities are installed to permit the delivery of these and other plant products to various markets. During the war, the plant manufactured 2.3 million barrels of 91 octane aviation gasoline which was utilized by various army training fields located in Texas, Oklahoma, and New Mexico. In addition, 1.75 million barrels of butanes were produced and utilized in various refineries in the synthetic rubber and 100 octane aviation gasoline program. From an average gas volume of 458 million cubic feet per day, the plant recovers products as follows: ethane-propane mixture 2,000 barrels; isobutane 1,000 barrels; normal butane 1,000 bar-



rels; 72 octane gasoline 9,100 barrels; and heavy naphtha 1,050 barrels.

It may be of interest to briefly describe the plant process and operation. Wet gas from the field producing wells is delivered to the plant at a pressure of 2200 psi and a temperature of 135°F. The gas is cooled to 90°F, prior to reducing to a pressure of 1800 psi. Separators installed upstream of the absorbers permit separation of the condensate prior to the delivery of the gas to the main absorbers operating at 1800 psi. Proper retention of the desired hydrocarbons contained in the condensate and the rich oil from the high pressure absorbers is accomplished through stage separation and re-absorption, these materials being successively flashed down to 800, 600, 200 and 35 psi prior to being charged to the distillation system. All residue gas in excess of plant fuel requirements is recompressed for gas sales or returned to the producing reservoir.

A two-still system is used for stripping products from the rich oil after it is heated to 550°F. in tubular type heaters. The No. 1 still operates at 90 psi. Overhead from this still goes to the depropanizer while bottoms are introduced near the top of the No. 2 still which operates at 2 psi. The overhead from the No. 2 still is a heavy naphtha oil, the bottom product is a 36 degree A.P.I. (500°F. initial boiling point) absorption oil for return to the absorbers. The overhead product from the No. 1 still, consisting of gasoline, butane, propane and lighter hydrocarbons, is processed in the fractionating unit for the production of various products previously mentioned.

Power and utility requirements of the plant are as follows:

Operating compressor hp.	13,350
Steam demand lbs/hr.	235,000
Electric kw	2,400
Absorption oil circulation gym	3,200
Cooling water circulation gpm	33,500

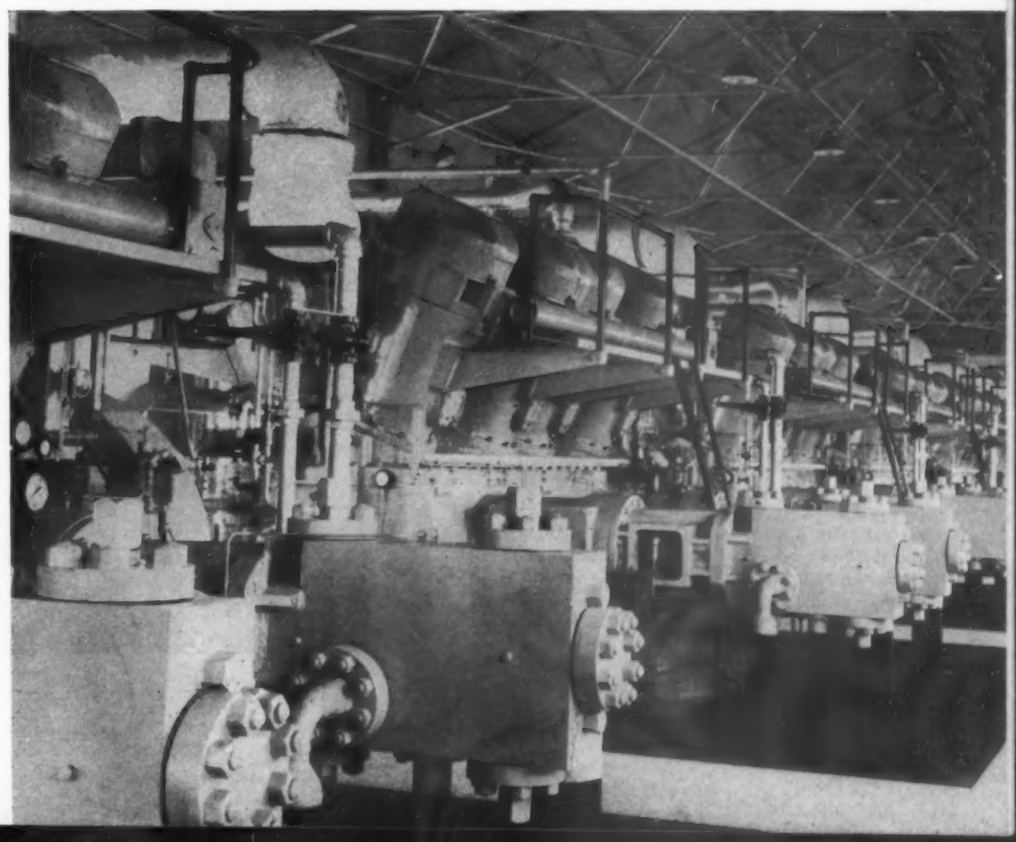
At present, there are 33 producing wells supplying the plant through 36 miles of gathering lines. Gas is being returned to the formation through 34 miles of line laid to 13 injection wells. Gathering lines were designed to operate at 2700 psi and 130°F. and water tested to 3,100 psi, while the injection lines were designed to operate at 3500 psi and 175°F. and were tested to 4100 psi. Well head assemblies on injection wells are designed for pressures up to 10,000 psi. One reason for this is to provide an ample safety factor against loss of metal due to corrosion.

The compressor plant for returning the residue gas to the injection wells consists of seven 800 hp. and seven 1000 hp. gas engine driven compressors. The compressors handle around 388 million cubic feet per day from a suction pressure of 1800 psi to a discharge pressure of 3150 psi. The injection lines are sized for a minimum pressure drop to permit flexibility in the distribution of the injection gas volumes.

Hydrocarbon Analyses and Plant Recoveries

Component	Composition—MOL Percent Inlet Gas	Residue Gas	Raw Products	Percent Recovery
Methane	90.57	94.86	0.32	0.01
Ethane	4.61	3.83	4.96	3.84
Propane	1.97	1.15	15.97	28.94
Isobutane	0.38	0.10	7.44	69.91
N-Butane	0.55	0.06	13.53	87.80
Gasoline & Heavy Naphtha	1.92	....	57.78	100.00
Total	100.00	100.00	100.00	3.42

Compressors discharge gas at 3,150 pounds per square inch pressure for reinjection into the formation.



OIL COMPANY STAFF CHANGES

G. M. Cunningham

GEORGE M. CUNNINGHAM, manager of Standard of California's newly-organized exploration department, has had a varied career that has taken him to many part of the world for Standard. Following his first job in the Semi Tropic area in the San Joaquin Valley, where he did topographical mapping, he was sent to Utah and Montana on exploration tours. Returning to California, he spent the next several years in exploration and map making and then became district geologist for the San Joaquin Valley in 1927. During this period he played an important part in the initial development of Kettleman Hills.

In 1933, Cunningham took Standard's first seismographic survey crew to Mexico. The party located the Cuichapa Field by the new method. He also was closely identified with work in the Rocky Mountains, the Gulf Coast and Canada and he played a part in the geophysical tests in Venezuela, Colombia, Saudi Arabia, Egypt, India and Netherlands East Indies. He was named assistant chief geologist in 1937 and chief geologist in 1943. He became general manager of exploration for the producing department in 1944.

CHARLES A. PERLITZ, JR., Houston oil man and attorney, has been elected executive vice president of Continental Oil Company. He succeeds W. W. Bruce who retired November 1. Born March 3, 1903, at Schulenberg, Texas, Charles Perlitz is one of the youngest senior executive of a major oil company in the United States. He moved as a boy to Houston where his father is president of the Schuhmacher Company, a wholesale grocery firm. From 1929 to 1938 he was a member of the law firm of Fulbright, Crooker and Freeman, Houston, and for the next seven years was associated with Strake Petroleum, Inc., Houston, a large independent producing company. He joined Continental Oil Company as general attorney at Houston on January 1, 1946.

Charles Perlitz has been an outstanding leader in the business and civic life of Houston. He is a member of the executive committe and a director of the Second National Bank of Houston, as well as a director in several other business organizations in Houston. He was the first president of the Junior Chamber of Commerce, in 1930, and at the same time served as a director of the Senior Chamber of Commerce, and also served three years on the Red Cross Board of Directors.

C. C. Crawford

DR. C. C. CRAWFORD has been appointed assistant manager of Phillips Petroleum Company's chemical products department. He will be in charge of the special products, product development, and Perco divisions. Dr. A. J. Dirksen was promoted to manager of the product development division, the position formerly held by Crawford. Dr. Crawford started with Phillips Petroleum Company January 1943 in the Special Products Division having previously been employed as a chemist with Shell Development Co. In March, 1944 he was made manager of the products development division.

O. J. HAYNES, newly appointed assistant general manager of Standard of California's exploration department, went to work for Standard in 1923. He entered the foreign division of the producing department in 1937 and served at Standard's London office as land and lease representative. In 1940, Haynes was transferred to Cairo as assistant manager of Standard's affiliate, South Mediterranean Oil Fields, Ltd. He returned to the United States in 1941 and has been superintendent of exploration in the southern division for several years.

O. J. Haynes

A. B. CAMPBELL, formerly eastern representative of Hughes Brothers, has accepted the position of executive secretary of the National Association of Corrosion Engineers, with headquarters in Houston. The association was organized in 1943 as a clearing house for the exchange of corrosion information, and for the establishing of standard procedures and methods of carrying them out. It will hold its second national convention in Chicago on April 7-10 at the Palmer House.

C. A. McCLELLAND has been made Mid-Continent sales manager for International Derrick and Equipment Company. His offices will be at Dallas where he is a member of the Dallas Petroleum Club and a charter member of the Dallas chapter of Nomads. He has been with Ideco for 10 years.

BERT PERSING NEWTON, vice president of Gulf Oil Corporation in charge of foreign marketing, has been awarded the order of the Lion of Finland, with the rank of Commander. The honor is the highest which Finland awards to civilians. It was conferred in Stockholm by the Finnish Minister to Sweden in recognition of services rendered by Mr. Newton to his country. Col. J. Frank Drake, president of Gulf, witnessed the ceremony.

A. L. NICKERSON has been elected a member of the board of directors of the Socony-Vacuum Oil Company, Inc. He went to work for Socony-Vacuum in August, 1933, as a service station salesman and rose through various positions in the company's marketing operations to the assistant general managership of the eastern marketing division. In 1945 he went to London as chairman of the board of the Vacuum Oil Company, Ltd.

R. R. GRIFFIN, formerly vice-president of the Shell Oil Company, Inc., New York, in charge of marine transportation, died October 22 at Oakland, California, after a long illness. Griffin retired from his post with Shell on August 1, 1946 after 25 years of service with the company.

HOMER A. GODDARD, lubrication engineer, has been appointed assistant division manager in charge of industrial lubricating sales for the Pittsburgh division of Gulf Oil Corporation, embracing Western Pennsylvania and West Virginia. He has been serving as superintendent of industrial lubricating sales for this territory. He succeeds S. A. Newman, who has been advanced to the position of chief turbine lubrication engineer in the general office.

Homer A. Goddard

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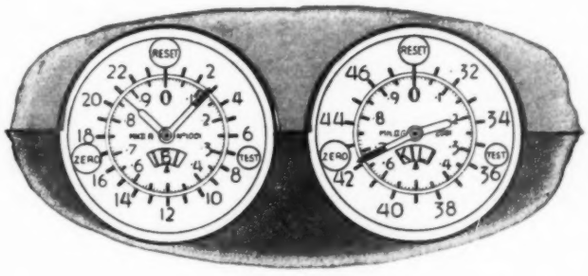

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OIL ISSUES BEFORE THE NEW CONGRESS

By WILLIAM J. MADDOX

Chief of World Petroleum's Washington Bureau

WHILE it is somewhat too early to forecast the activities of the Eightieth Congress which meets for its first session in January, it will have before it several important issues affecting the oil industry and the change in political complexion may affect the majority attitude on some of these. Since the vote on November 5 is recognized as registering an emphatic protest against the continuation in peacetime of governmental controls set up under the war emergency Congress undoubtedly will be disposed to put an end as promptly as possible to such controls as may remain. Moreover, one of the issues stressed by the Republicans during the campaign was opposition to regimentation and the intrusion of federal authority into fields that in the past have been left to private enterprise. Consequently, it is fair to assume that some of the pet projects for expansion of federal activities may find little sympathy in the new Congress and the agencies that have been promoting such enterprises may find their operations sharply curtailed.

One question that may be affected by the change in the political atmosphere is the fate of the Anglo-American oil pact which has been gathering dust in the Senate Foreign Relations Committee for months suffering from a bad case of committee-inertiaship. Reluctance of the committee to take up the agreement in the last Congress was due in part to the unenthusiastic attitude of Chairman Tom Connally of Texas, a state from which violent opposition to the pact has stemmed.

Now, with the Republicans in control of the Senate, it is a foregone conclusion that the chairmanship of the committee will go to Senator Arthur Vandenberg of Michigan. Vandenberg's attitude toward the pact itself has never been clearly defined, as he has been occupied since its reception by the committee with his work with the Big Five of the United Nations. However, it is believed that his experience with UN has given him an international viewpoint that may incline him to favor such a treaty.

On the other hand, renewed opposition to the treaty has developed within the oil industry, largely as a result of a broadcast some two months ago by representatives of the State Department in which the Anglo-American agreement was represented as a step toward the establishment of an international petroleum commission for which broad authority over international oil trade was suggested. While the broadcasters were not speaking officially their remarks revived the fear that had been felt in various quarters that the State Department actually favored a form of international control over oil that would regulate production, exports or imports of the United States. New protests arose against any move tending in this direction and the Independent Petroleum Association withdrew its former endorsement of the pact while the American Petroleum Institute asked for a clarifying statement. Further qualifying clauses undoubtedly will be proposed when the treaty comes up for consideration and a lively debate appears inevitable.

Another factor that may influence the attitude of Congress toward the whole question of oil policy will be the findings of the Special Senate Oil Investigating Committee. This Committee, headed by Senator O'Mahoney of Wyoming, has finished its fact-finding and is well into the work of preparing its final report for presentation to Congress. This will probably be ready shortly after the new Congress assembles, when the committee automatically expires. Under the Congressional reorganization act all investigations in the future supposedly will be conducted by standing committees, so it is unlikely that the life of the special committee will be extended.

The O'Mahoney report will be designed to furnish a basis for a definite and permanent policy on all government actions regarding petroleum reserves, development, imports, foreign operations, and other domestic and foreign industry problems.

Tidelands control is another question that may enlist the attention of Congress. In the final days of the Seventy-ninth Congress a resolution was passed confirming state authority over adjacent tidelands. It was vetoed by the President on the ground that the question was before the Supreme Court and the Court's decision should be awaited before any action was taken. If the Court finds in favor of state control the matter will be disposed of but in case of a contrary decision Congress may feel disposed to reassert state authority and might override another veto should one be forthcoming.

Other matters that may enlist the attention of Congress are the legislation urged by the Civilian Production Administration to keep alive the war-born $800,000,000 synthetic rubber industry; the investigation of the War Asserts Administration, which undoubtedly will have a bearing on the sale of the Big and Little Big Inch pipelines; legislation to be sought by the Interior Department to definitely bring natural gas under the conservation provisions of the Connally "Hot Oil" Act; and a report from Secretary of Interior Krug on coordinating and unifying the policy and administration of the 31 Federal agencies concerned with petroleum and natural gas. Officials who are favoring an appeal to Congress for legislation to protect the synthetic rubber industry say that national security makes it imperative to continue controls over rubber. They contend that legislation is needed to replace the War Powers Act, which expires March 31, so that tire and rubber manufacturers may be compelled to use a substantial amount of synthetic rubber. Such action, they say, would keep the synthetic industry on a going basis until Congress decides on a national rubber policy, which probably would include a subsidy for synthetic plants.

With the production of natural rubber now on the upswing, the fear is expressed that manufacturers left to themselves might turn to natural rubber, virtually abandoning synthetic and come out with "premium" tires. A clause in the recent liberalizing OPA order, allowing a higher percentage of natural rubber in tires, may make possible the return of "premium" tires, commanding a higher price for quality.

The clause in question permits a manufacturer to increase the amount of natural rubber by 10 percent in any tire size, so long as he reduces the amount in other sizes sufficiently to stay within his total allotment. Thus a 33 percent natural-rubber tire could be produced instead of 23 percent. By thus increasing the natural rubber content, a company might be able to justify the imposition of a higher price, though the pricing agency is not committed to make any such increase.

The Oil and Gas Division's survey reveals that there are 31 federal agencies engaged in activities relating to petroleum and natural gas. The canvass was made by the newly created office for the purpose of coordinating and unifying oil policy and administration in the government. A full report will be drawn up for presentation to the President and interested committees at the next Congress.

Acting OGD Director Ralph Davies explains that some of these agencies have only relatively minor functions and the responsibilities of others are of a highly specialized nature or governed by statutory or executive regulations.

"Where practicable and appropriate," Davies says, "governmental activities will be centralized with a view to elimination of duplication and development of a coherent, foreward-looking program to secure the continued availability of adequate supplies of petroleum for our national economy and security in the future. Proposals designed to accomplish these objectives will be submitted for consideration from time to time, in accordance with the President's direction."

May the holiday season bring you the peace of mind that is symbolized by the gleam of a burning candle. May you and yours enjoy, throughout 1947, the glow of radiant health. May the coming year be all that you want it to be. This is the sincere Christmas wish of the makers of

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International News and Notes

Dr. Victor M. Lopez

Dr. Lopez Honored

Double honors have been bestowed recently upon Dr. Victor M. Lopez, Director del Servicio Tecnico de Mineria y Geologia del Ministerio de Fomento, in Caracas. First he received, through the United States Embassy in Venezuela, the "Medal of Freedom" conferred for services to the Allied cause during the last World War. This particular medal is an honor of real distinction since it is awarded only in cases of exceptional merit. Winston Churchill, former British Premier, was one of the recipients. It happens that Dr. Lopez is the first Venezuelan to whom it has been presented. The second honor was a gold medal bestowed by the Sociedad Venezolana de Ciencias Naturales, for the best scientific work published in Venezuela in 1945. This publication deals with the copper deposits of Aroa in the State of Yaracuy. Dr. John C. Davey of the same office, and Dr. Enrique Rubio of the Central University in Caracas were collaborators in this work and received diplomas in recognition of their contributions.

During the fourteen years that Dr. Lopez spent in exile, he obtained a degree in Mining Engineering from Columbia University in 1929 and an M.S. in Geology from the Massachusetts Institute of Technology in 1936. The following year he received his Ph.D. there. His experience was not limited to academic studies. He worked underground in the copper mines of Butte, Montana; was a draftsman in New York; did geological work for the copper mines of Chuquicamata, Chile, and was instructor in a number of colleges. Aside from his distinction as a scientist Dr. Lopez has held many offices of trust, belongs to many technical and honor societies and has published numerous articles on the mineralogy and geology of Venezuela and Chile.

Drilling in Australia

In the Kimberley area in Australia Freney Oil Company is preparing to resume drilling operations that were interrupted by the war. The company has made application for a loan of £30,000 which it estimates as sufficient to put a bore down 4,500 feet. The government would like to have the test carried to a depth of 6,000 feet and apparently is prepared to bear the extra cost involved. The area to be tested comprises approximately 550 square miles at Nerrima Dome and is favorably regarded by geologists.

Italy Considers Oil Exploration

Renewed interest in oil exploration has developed in official quarters in Italy since the war in view of the importance of an adequate fuel supply to the industrial progress and the financial burden imposed by the necessity of importing both oil and coal. In addition to the arrangement recently reported between the Agienda Generale Italiana Petroli (AGIP) and Standard Oil Co. (N. J.) it has been stated that British and Dutch interests have investigated the possibility of undertaking exploration on the Italian peninsula but have withdrawn because of the limited areas for which the Ministry of Industry was willing to grant concessions and because of its refusal to provide definite terms for the exploitation of oil that might be discovered.

Information released by AGIP covering the exploratory work that it has conducted in the Apennine region indicates that geological studies and drilling tests disclose little prospect of substantial oil production. More favorable structural formations exist in the Po valley, at Podenzano, San Giorgio Piacentino and Lodi. Farther south negative results have been shown except in the Pescara valley, the Valle Latina and Tramutola and even there they have not been impressive.

In Sicily exploration has not extended far enough to provide a substantial basis for conclusions but it is suggested that an examination of the deep formations underlying the Triassic might lead to commercial production.

Argentine Oil Production

The Argentine Office of Statistics reports that the total production (including Government-operated and privately-owned fields) of crude oil during the first six months of 1946 was 10,355,000 barrels. The figures for the corresponding period in 1945, and production for the various districts, are shown in the following table:

	Thousands of U. S. Barrels	
District	1945	1946
Commodoro Rividavia	8,299	7,245
Plaza Huinal	1,079	1,079
Salta	669	518
Mendoza	1,511	1,493
Total	11,588	10,355

During the period concerned all districts showed a natural gas and natural gasoline during the first semester of 1946 was 10,073,918,000 cu. ft. and 36,709 bbl., a decrease of 11.3 and 10.2%, respectively, in comparison with 1945.

The Argentine General Gas Administration has acquired three large manufactured gas plants located in the Province of Buenos Aires, and will connect them with the La Plata-Buenos Aires pipe line to enhance the supply of gas to the city of Buenos Aires. The announced intention of the government is to acquire, eventually, all public gas services in the country for state operation.

National Council for Colombia

Dr. L. Buenhora, recently appointed Minister of Petroleum in Colombia is moving energetically to bring about an effective revision of the country's oil law, a matter that has been under discussion for the past several years but on which no final action has been taken. Dr. Buenhora has asked Congress to establish within the Ministry a National Petroleum Council of four members, one each to be appointed by the Senate, the House, the Supreme Court and the Executive branch of the government. Its immediate task would be a study of the oil bill now before Congress and recommendation for its improvement. The existing law is criticized as imposing long delays and unnecessary complications in dealing with applications for concessions.

Surveys Bolivian Line

The Yacimiento Petroles Fiscales, the Bolivian oil administration, has contracted with Williams Brothers, Inc., of Tulsa, for the surveying, ditching, laying and completion of a 255-mile six-inch pipeline from the Camiri pool and refinery near the Chaco region of southeastern Bolivia to Tin Tin, in Cochabampa province.

Engineers are now on the ground making a physical survey before pipe and equipment is moved into the republic. The new line may be extended to Cochabama later.

THOMAS W. PALMER, head of the Latin-American legal staff of Standard Oil Co. (N. J.) recently was awarded the Venezuelan order of the Liberator with rank of commander. This is the highest honor which Venezuela bestows on a foreigner. Presentation was made by Dr. Enrique Gonzales-Navas, consul-general for Venezuela at New York who read the citation reciting Mr. Palmer's contributions in promoting better relations between Venezuela and the United States.

Mr. Palmer has spent many years in South American countries and taken an active part in fostering understanding among the Americas. In 1936 he was decorated by the Brazilian government with the Order of the Southern Cross for similar activities. Past president of the Venezuelan Chamber of Commerce of the United States, Mr. Palmer also is president of the Pan-American Society and is a founder member of the New York Chapter, Bolivarian Society.

YPF's Technical Director

The new technical director of the Argentine Yacimientos Petroliferos Fiscales is Ingeniero Juan N. Catinari. Senor Catinari has been active in the Argentine mineral industry since 1908 and is credited with the discovery of the Comodoro Rivadavio and Plaza Huincul oil fields. He helped design and build the refinery at La Plata, and in 1945 headed a commission to purchase oil field equipment in the United States.

For Equipment Purchases

By decree of the Secretary of Industry and Commerce of Argentina, Yacimientos Petroleos Fiscales, government owned oil company, has been authorized to open a special credit of 12,500,000 pesos ($3,125,000) for the purchase of machinery, materials and supplies urgently needed to carry on its regular activities.

Guests of Nomads

Among the representatives of international oil companies who were guests of the Los Angeles Chapter of Nomads at their October meeting were R. H. Conners and Harry D. Huskey of Iraq Petroleum Co., Ltd., Guy P. Harveys of Bahrein Petroleum Co. Ltd., Bahrein Island, George A. Firestone of Attock Oil Co. Ltd., India, and Walter L. Little of Tropical Oil Co., Columbia.

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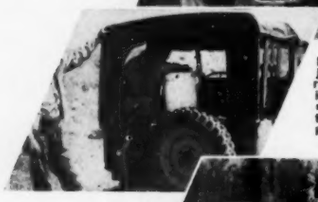

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The availability in drum or tank car quantities of isooctane (2, 2, 4-trimethylpentane) of 99.9 mol percent purity has been announced by the chemical products department, Phillips Petroleum Company, Bartlesville, Oklahoma. This is the second new hydrocarbon development from this concern in recent months. Pure grade normal heptane was made available in April, 1946. The new Phillips isooctane has an ASTM octane number of 99.96. Density at 20° C. in grams per ml. is 0.692. Freezing point is minus 107.43° C. Temperature at 50 percent recovery during distillation is 99.24° C.

New Kellogg Laboratory

A complete new group of pilot plants now building for extensive industrial research to prove the feasibility of a wide range of new processes and their application to many basic industries, has been announced by L. H. Harvison, executive vice president of The M. W. Kellogg Company. Mr. Harvison stated that the Kellogg Company, whose Jersey City laboratory operations in the petroleum refining and related fields have for years represented an annual investment running into seven figures, now is embarking on a comprehensive program of expanding these facilities. One of the major units of the new laboratory is the pilot plant for a special solvent process for refining of edible oils, vitamins, fatty acids, tallow and other glyceride products.

Replaceable Insert Wipers

A new line of drill-pipe wipers has been developed by Baroid sales division of National Lead Company. In addition to one-piece types Baroid has a new wiper with replaceable inserts. When wear or damage from tool joints or protectors make the new wiper ineffective the operator need only replace the worn insert. Since one rim will replace several inserts the new wipers are said to extend normal life of such devices several hundred percent. Operations are simplified since one rim may be used with two inserts for different size drill pipe.

Model Conservation Law

The Interstate Oil Compact Commission's amended suggested Oil and Gas Conservation Laws, approved for publication at its Grand Rapids meeting, now are being distributed. These forms embrace a suggested unitization statute. Copies of the pamphlet may be obtained from the Commission's headquarters office in Oklahoma City.

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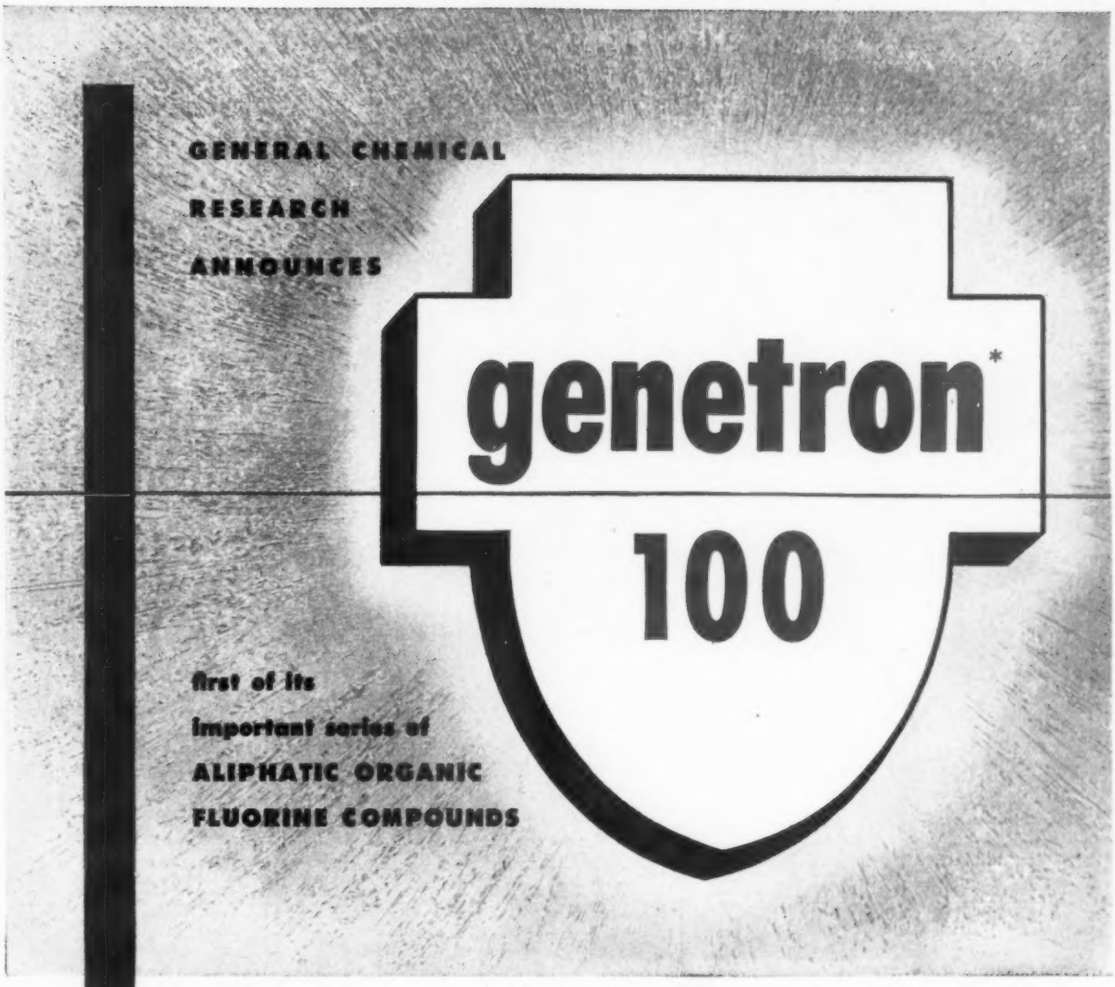

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Formula	CH_2CHF_2
Molecular Weight	66.05
Color	Colorless
Melting Point	−117.0° C
Boiling Point	−24.7° C
Density	1.004 at −25° C
Latent heat of vaporization	127 B.t.u./lb.

vapor pressure (p.s.i. abs)

−30° C	12.0
−10° C	25.9
10° C	53.8
30° C	108.0

Magnolia Drilling In Gulf

Five miles off the coast of Louisiana near Morgan City, the Magnolia Petroleum Co., is drilling below 8,000 feet. Water depth at the rig is 16 feet.

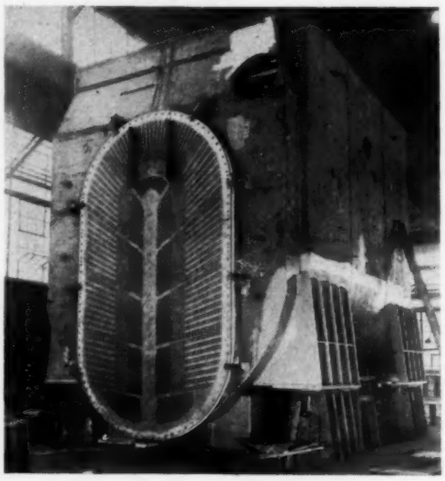
Magnolia's lease is from the Louisiana state mineral board. Other exploration has been carried on in the Gulf of Mexico, but none was beyond two miles from shore. Several companies are drilling and producing in some of the bays and sounds and there are shut-in gas wells nearby.

Magnolia's short base is at Morgan City, 37 miles from the rig, from where supplies and fresh drinking water are shipped. The crew makes its headquarters in "Magnolia Inn," a spacious houseboat tied up at a small island ten miles from the rig. The living quarters consist of bedrooms, galley, dining room, club rooms and showers. Radio communication links the rig, living quarters, Morgan City and the seismograph crews.

New Crude Stock Survey

A nation-wide survey to determine the actual character and availability of refinable crude oil stocks will be undertaken by the Interstate Oil Compact Commission. Last survey of petroleum stocks was made by the Bureau of Mines in 1936-37, and revealed that approximately one-third of the crude oil in storage then was in pipeline fill and working stocks, thus not being available for immediate usage.

During recent years the distribution of stocks has changed, when the Bureau of Mines announced that it would be unable to make such a survey because of lack of funds, and the Economics Advisory Committee then recommended that the Commission undertake such survey. Industry will be asked to list net refinable crude on leases, in pipelines, in working and storage tanks, at refineries, and in transit. Data also will be requested with reference to tank bottoms at refineries, in working tanks, storage tanks, and in pipeline station tanks.



Foster Wheeler Builds Huge Condensers

The Foster Wheeler Corporation has completed construction at its Carteret, N. J., plant of the two largest cross-flow condensers ever built. Each unit will condense exhaust steam from a turbine of 150,000 kilowatt rated capacity. Water circulation will be 146,000 gallons per minute through the condenser tubes, equivalent to the daily domestic water requirements of more than 6,000,000 persons. At the higher loads 1,300,000 pounds of steam per hour will be condensed in each unit.

Oil Burner Orders High

A backlog of approximately 1,600,000 unfilled orders for flue-connected oil burning space heaters is reported by the United States Bureau of Census. This backlog will require an upward revision of manufacturing schedules for vaporizing oil burners from an estimated 1,000,000 new burners per year to 1,300,000 to 1,500,000, with a corresponding increase in the demand for fuel oil. Manufacturers say, with new burners rapidly being added to the 2,500,000 already in operation, fuel oil requirements for vaporizing burner heating now are approaching 50,000,000 gallons per year with a retail sales value of close to $200,000,000, largest in the domestic heating field.

The Institute of Cooking and Heating Appliance Manufacturers predicts, that million new space heaters per year will be needed, principally for the nearly 20,000,000 dwelling units in the country which have no central heating systems and for proposed new dwelling units. These will create a new fuel oil market of about 15,500,000 barrels annually. Between 300,000 and 500,000 new vaporizing oil burner floor furnaces, circulating warm air furnaces and water heaters will be needed. For these three types of equipment, additional fuel oil sales probably will total from 4,650,000 to 7,750,000 barrels annually the institute estimates.

Uniform Pressure Recommended

Recommended pressure base of 14.65 pounds per square inch (4 ounces above assumed atmospheric pressure) was adopted by the Oklahoma Corporation Commission on October 25 in revision of its general rules and regulations. This is the first state to act on recommendation of the Commission's Research and Coordinating Committee, designed to bring about uniformity in reporting of natural gas production.

...ration shows the completed construction in the Whessoe works of a Vacuum Column for a British Oil Refinery. This unit is 4 ft. dia by 63 ft. high.

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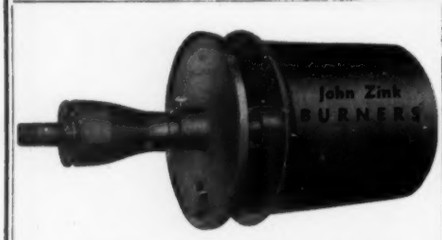

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Concrete Research Project

A research project for study of the waterproofing of mortar and concrete through the use of petroleum derivatives has been established by The Texas Company at the University of Colorado. It is suspected from the published work that even small amounts of asphalt and related petroleum derivatives may greatly increase the water resistance and flexibility of concrete. It is known that petroleum materials increase the amount of air that can be incorporated in the concrete mix, increasing the resistance to freezing and thawing.

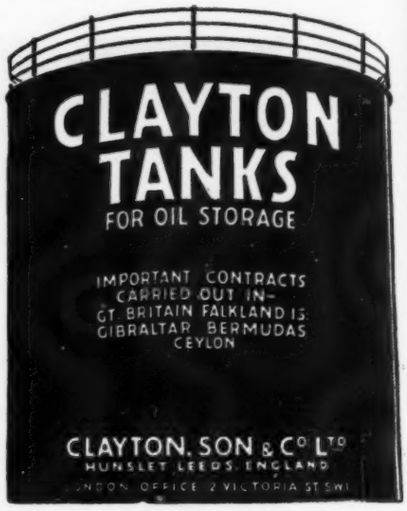
Professors Warren Raeder and William H. Thoman will supervise the project, assisted by D. G. Kretsinger, associate research engineer of the experiment station. Several graduate students in civil and architectural engineering will work with Mr. Kretsinger.

Bulldozer Cleans Tanks

Cosden Petroleum Corporation has found a new use for the versatile bulldozer. Equipped with side plated blades it is being employed to clean out their 80,000-bbl. tanks at Big Spring, Texas. Over a period of years the bottoms of the tanks became hard packed with a solid residue four or five feet thick. By removal of a bottom ring sheet the bulldozer is able to move inside where it gouges out the residue and pushes it through the opening. The machine clears a tank in from two to three days are compared with as many weeks when hand labor was used.

700 War Veterans in Hughes School

Hughes Tool Company of Houston is giving more than 700 war veterans a course in machine shop practices. The ex-soldiers are taking three hours of theory in the plant yard under the tutelage of University of Houston professors. The remaining five hours of the work day is spent in the shops where the theory is applied to actual work. Work turned out by the GI's is running well above standards for beginners, say the Hughes people, who are enthusiastic about the setup.



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Klinger Reflex Level Indicators withstand pressures up to 1,200 lbs. per square inch, and temperatures up to 800° F. They can be built up to any desired length, and are suitable for high-pressure stills and cracking plant, for reaction chambers and for all purposes where variations of temperature and pressure are severe. All component parts are standardised: Klinger gauges are easily maintained or replaced.

"Klingerit," the universal compressed asbestos sheet packing (high pressure jointing) is available in sheets up to 80″ x 240″ in area, and in thicknesses from .008″ to ¼″. Suitable for use on all modern high-pressure plants — oil, chemical and industrial—it will withstand working pressures of 5,000 lbs. per square inch and temperatures of 900° F. Impervious to steam, gases, chemicals and oils, "Klingerit" can also be supplied as ready-cut gaskets.

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Paul Gosman

PAUL GOSMAN has been appointed manager of the advertising and sales promotion department of Socony-Vacuum Oil Company, Inc. to succeed Eben Griffiths who has retired.

Mr. Gosman joined the Vacuum Oil Company in 1925. He was assistant to the general manager of the automotive sales division and, following the merger of Socony and Vacuum in 1931, he became a member of the sales promotion department. Later he was made sales promotion manager.

Mr. Griffiths was city editor of the Brooklyn Eagle in 1916 when he joined the advertising department of Vacuum Oil Company. He was made advertising manager of Vacuum in 1918 and in 1931 became advertising manager of Socony-Vacuum. He has been for many years a director of the Audit Bureau of Circulations and is a member of the Administrative Committee of the Continuing Study of Newspaper Readership, which is part of the Advertising Research Foundation. He is a life member of the board of trustees of St. Lawrence University and a member of the executive committee.

Patterson-Ballagh Field Transfers

Patterson Ballagh division of Byron Jackson Co. has announced a number of transfers and new appointments among its field sales force. A. L. "Preach" Gooden, formerly at Alice, Texas, has been transferred to Rangely, Colorado. He will not cover the Casper area, since J. B. Buchanan, who also works for Byron Jackson Co., will handle the Patterson-Ballagh line in that territory. J. M. "Jimmie" Newton is now stationed at Baton Rouge, Louisiana, and covers the fields in Mississippi and the Harvey, Louisiana, district. Wiley B. Gardner is now living in Mooringsport, Louisiana. He covers sales and services in the Northern Louisiana, Arkansas, and East Texas fields.

C. J. "Chili" McKernan is now stationed at Odessa, Texas. During the war he was in the Air Corps and was discharged last December. He will be Patterson-Ballagh's factory representative in the West Texas, Panhandle, and New Mexico Area. H. H. "Bud" Collins is now in Southwest Texas succeeding A. L. "Preach" Gooden. He is working out of Alice, Texas.

Heads Ideco Eastern Sales

Martin J. Rampp has been appointed manager of oil field sales, International Derrick & Equipment Company's eastern division, it was announced by O. M. Havekotte, President. Rampp will maintain his headquarters at Marietta, Ohio, where he will continue to manage the Marietta plant in addition to his new duties. Rampp has produced and sold oil field products in the east for many years. He will supervise both direct and dealer sales of oil field and water well equipment.

GUY L. TATE is the newly elected vice president of Magnolia Petroleum Co. in charge of marketing operations. Mr. Tate got his first job with Magnolia 31 years ago as a clerk and has moved steadily upward since then. He succeeds George Miller who resigned because of ill health.

Guy L. Tate

'CLINSOL' STRAINERS
FOR FUEL OIL
LUBRICATING
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Design approved by the Admiralty Classification Societies
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SEAMLESS DRAWN TUBES IN COPPER, BRASS, ALUMINIUM, 'YORCALBRO' (Aluminium-Brass), CUPRO-NICKEL AND ALL NON-FERROUS ALLOYS

We specialise in the manufacture of seamless drawn Heat Exchanger and Condenser Tubes for the Oil Industry.

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NON FERROUS TUBES MADE ALSO IN SCOTLAND AT OUR BARRHEAD WORKS

Phillips' Patents

A handsomely printed book of 206 pages entitled "Summary of Technical and Patent Assets" has been issued by the Phillips Petroleum Company. In its manifold activity as a fully integrated oil company which explores for raw material, produces, manufactures, refines, transports and markets crude oil, natural gas, petroleum products and chemicals, Phillips has accumulated a mass of diversified technical and engineering data, a good deal of which has been embodied in 1110 patents. The book gives descriptions of these patents which cover such subjects as motor fuels, chemicals, synthetic rubber, carbon black, lubricants, catalysts and catalyst regeneration, exploration and well logging. Oil and gas production, liquefied petroleum gas, instrumentation and apparatus, and miscellaneous subjects. The company's technical and patent position is especially strong in catalytic cracking and reforming. Many of these patented processes and methods are offered for license.

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- *fundamentals*
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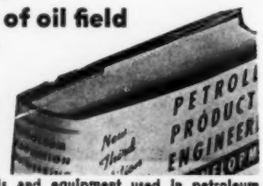

The new edition of this complete reference book on the fundamentals, problems, methods and equipment used in petroleum production, supplies a broad, practical understanding of the field, and a modern guide to the best practices in all steps of oil field development. It presents a comprehensive review of the field to meet the needs of engineers and petroleum executives alike.

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The book covers in careful, practical detail the range of processes from petroleum exploration methods, through principles of development, drilling equipment and methods, procedures in casing wells, water exclusion, well testing and completion, logging techniques, etc. It is the most detailed treatise on these topics available.

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- New and more efficient types of drilling equipment
- New methods of installing and cementing casing in wells
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Book Review

In "The Valley of Oil" Harry Botsford tells in entertaining fashion some of the striking incidents of oil discovery and development in the early days along Oil Creek in Western Pennsylvania. The fortunes and failures of some of the unusual men who played major or minor roles in the new and little understood business fill many of his pages. A detailed account of Edwin L. Drake and his connection with the drilling of the discovery well occupies the first section of the book. The rise and fall of Pithole, Red Hot, Petroleum Center and other phantom cities is described. An interesting chapter is devoted to the sojourn of John Wilkes Booth in the oil country when he started on the journey that took him to Washington and the assassination of Lincoln. The spirit and turmoil of the time, the tragedies and comedy that marked the birth of the oil industry are reproduced with fidelity in Mr. Botsford's book.

"The Valley of Oil" by Harry Botsford, 278 pages, published by Hastings House, $3.00.

Standard Test Methods

The seventh editoon (1946) of the "Standard Methods for Testing Petroleum and its Products" has been issued by the British Institute of Petroleum (London, W. 1, England. $4.00).

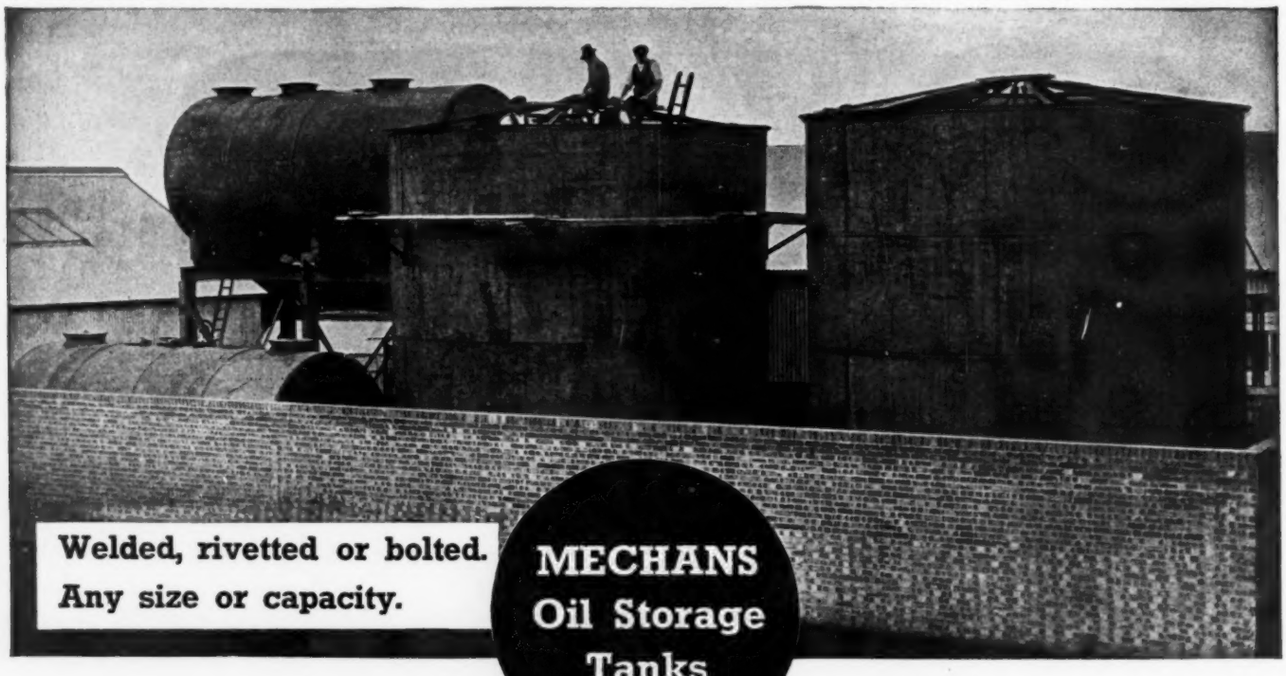
The 550 pages of this well established manual contains all approved methods used in petroleum testing laboratories. Only two new methods have been included and these are modifications of previous standard tests and slight revisions have been made in some others.

Henry Chalfant

Elected National Supply Director

Henry Chalfant, descendant of one of the founders of Spang-Chalfant and Company, now a division of The National Supply Company, has been elected a director. He fills the vacancy recently created by the retirement of P. J. Shouvlin. Mr. Chalfant is assistant secretary of National. During the war he was in the African and European campaigns as a Lieutenant Colonel in the Army Air Forces.

ILLUSTRATION SHOWS TANKS DURING ERECTION AT OIL SERVICE STATION



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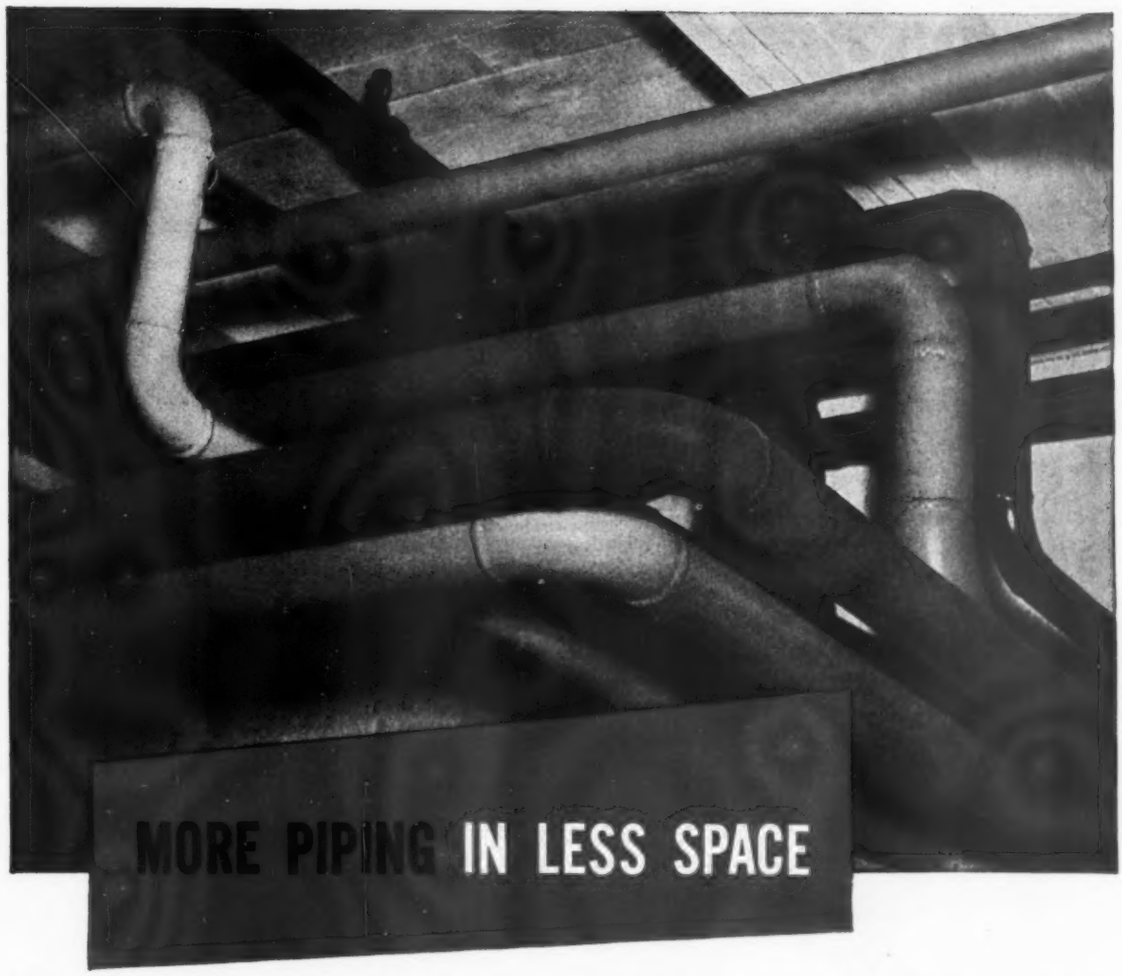
TELEGRAMS: "ELONGATION, LONDON" LONDON: 10, PRINCES STREET, WESTMINSTER, S.W.1. TELEPHONE: WHITEHALL 4288



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Unlike many industrial items today, there is still a fairly good supply of Tube-Turn welding fittings because Tube-Turn distributors located in every strategic industrial center in America had the foresight to maintain large stocks in nearly all sizes. Tube-Turn welding fittings, long recognized for their uniform wall thickness, smooth inner wall and extra strength, are available in carbon steel in sizes from one-half inch to 30 inches. Popular sizes also available in types 304, 347, and 316 stainless steel, in copper, copper bearing steel, aluminum, monel, inconel, nickel, carbon moly, chrome moly, and brass.

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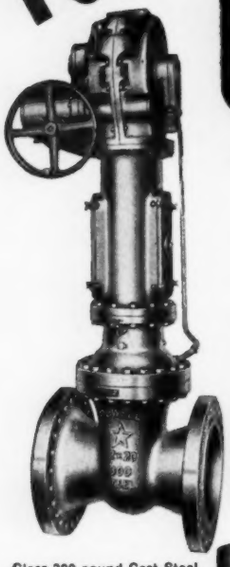

Class 300-pound Cast Steel Gate Valve. Has 12" port size venturied to 20" size end flanges to accommodate insulated pipe. Provided with top-mounted, enclosed electric motor operator.

Large 125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Gate Valve.

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200-pound Bronze Gate Valve with renewable disc.

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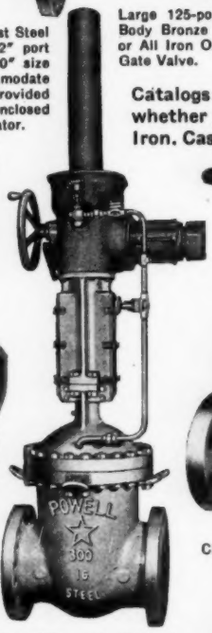
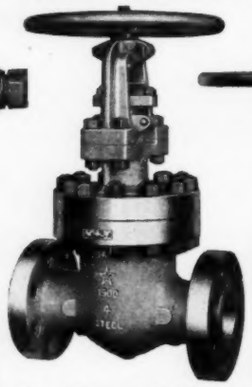
200-pound Bronze Globe Valve with regrindable, renewable seat and disc.



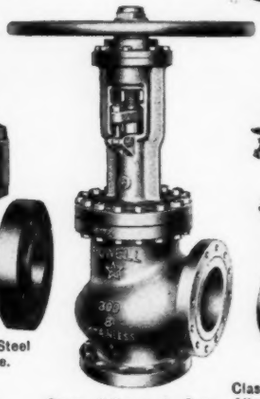
Class 300-pound, 16" Cast Steel Gate Valve. Provided with automatic steam sealing mechanism and electric motor operator.

125-pound Iron Body Bronze Mounted or All Iron "Master Pilot" Gate Valve.

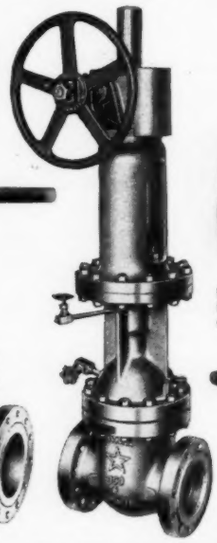


Class 1500-pound Cast Steel O. S. & Y. Gate Valve.

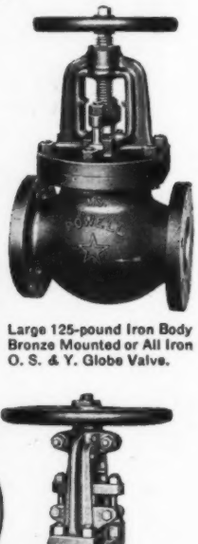
Class 150-pound Cast Steel Swing Check Valve.



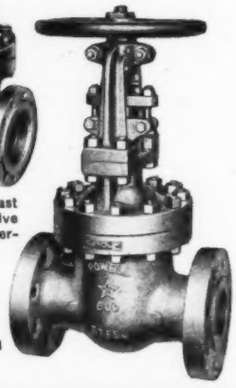
Class 300-pound Cast Alloy Steel O. S. & Y. streamlined Angle Valve. Adapted for high temperatures up to 1400 F.



Class 300-pound Cast Alloy Steel Gate Valve for ultra-high temperatures. Has cooling fins to reduce the temperature in the stuffing box.



Large 125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Globe Valve.



Class 600-pound Cast Steel O. S. & Y. Gate Valve.

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provide 1,500,000 pounds of steam each hour for the production of butadiene, so vital to America's synthetic rubber program. The steam is used directly in process and for prime mover power with exhausts for process purposes.

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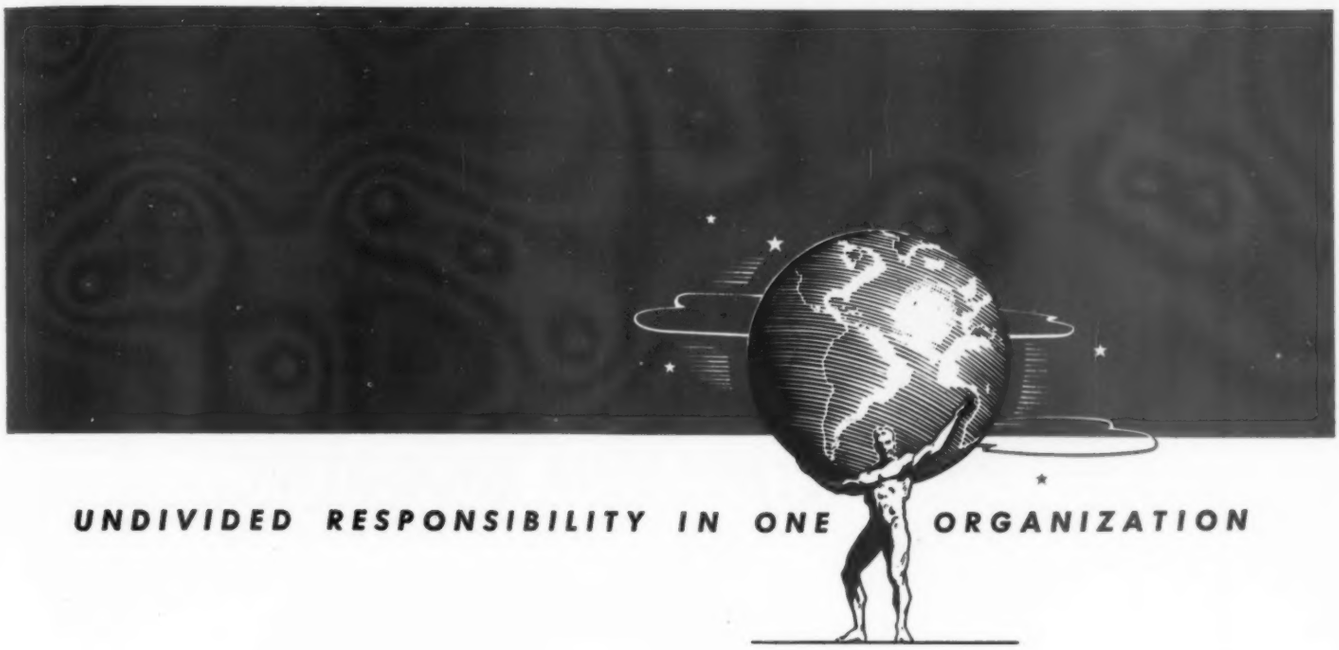

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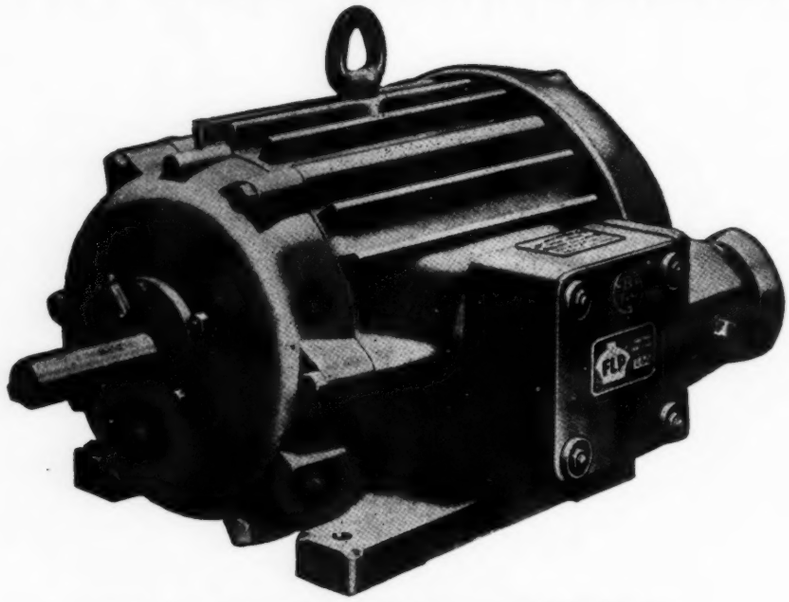

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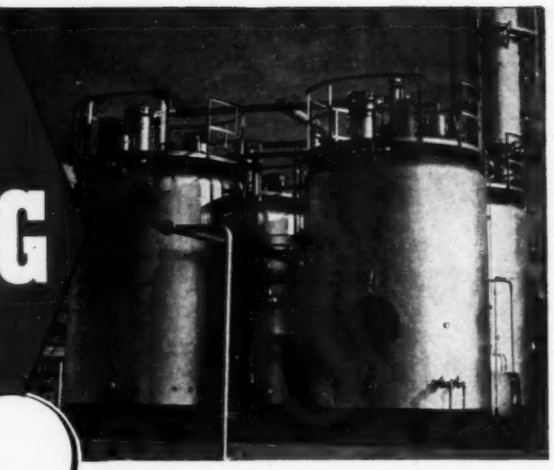

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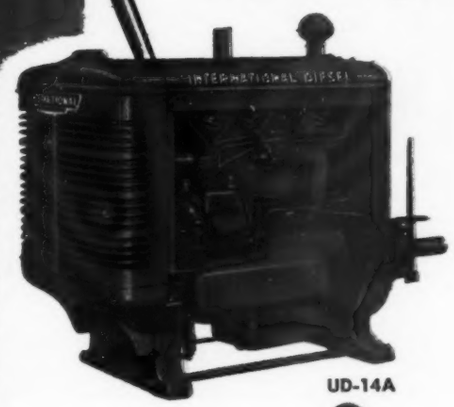
Another advance in INTERNATIONAL DIESEL POWER



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UD-18A

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Better Operating Economy! Even with horsepower stepped up, these Diesels run cool under heavy loads and operate at new low cost per horsepower. A low rate of fuel consumption proves their efficiency.

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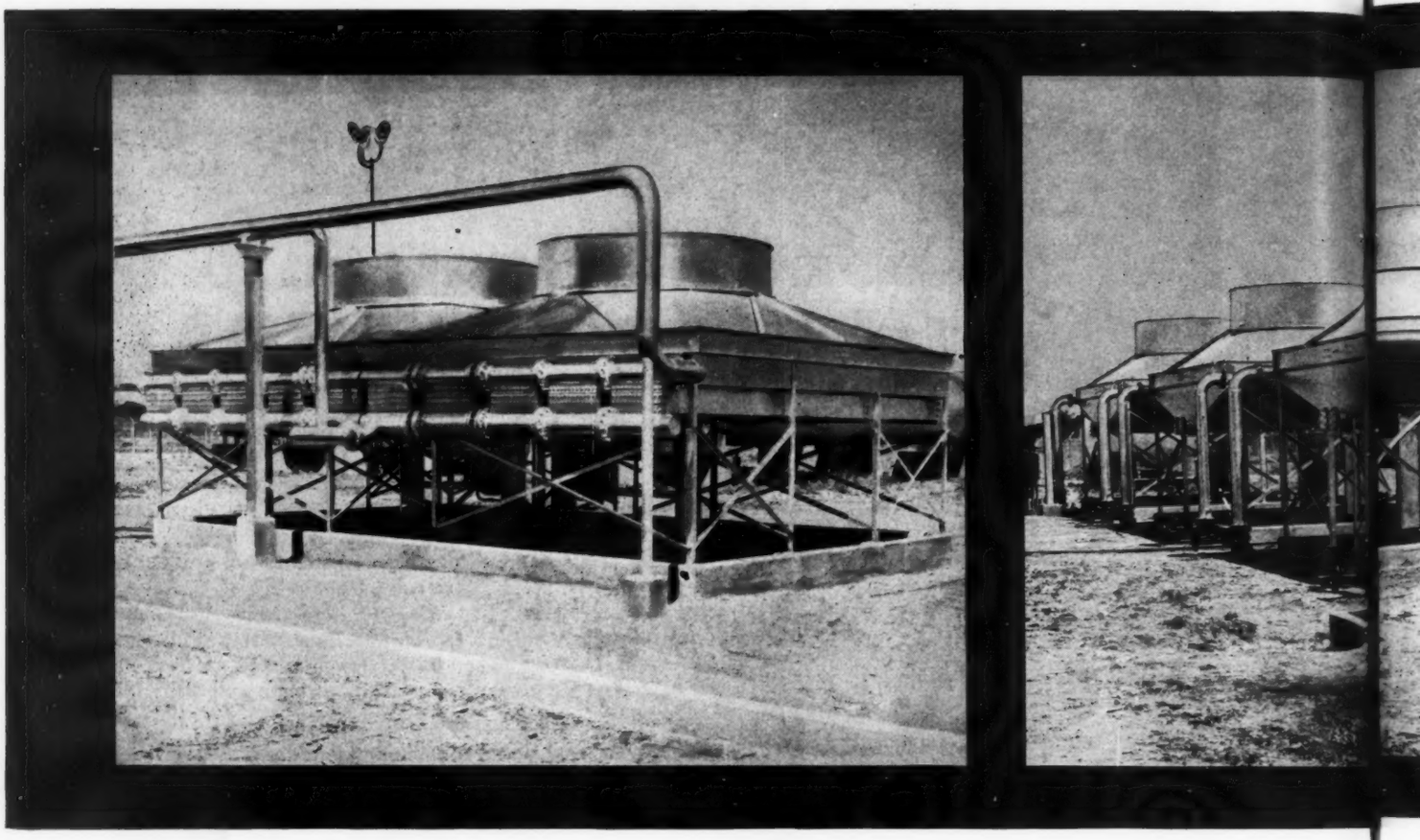
Most Complete Air Cooled Heat Exc



ALCO Air Cooled Heat Exchangers at Warren Petroleum Company's natural gas plant, Holiday, Texas, built by J. F. Pritchard Company, perform a greater part of all cooling operations than has ever been done before by air cooled heat exchangers in any comparable plant in the entire world.

13 MILLION CU. FT. GAS PLANT. This Warren plant has a processing capacity of 13 million cu. ft. of natural gas per day. All gas-cooling, vapor-cooling, and engine-jacket-water-cooling in this big plant are done by ALCO Air Cooled Heat Exchangers.

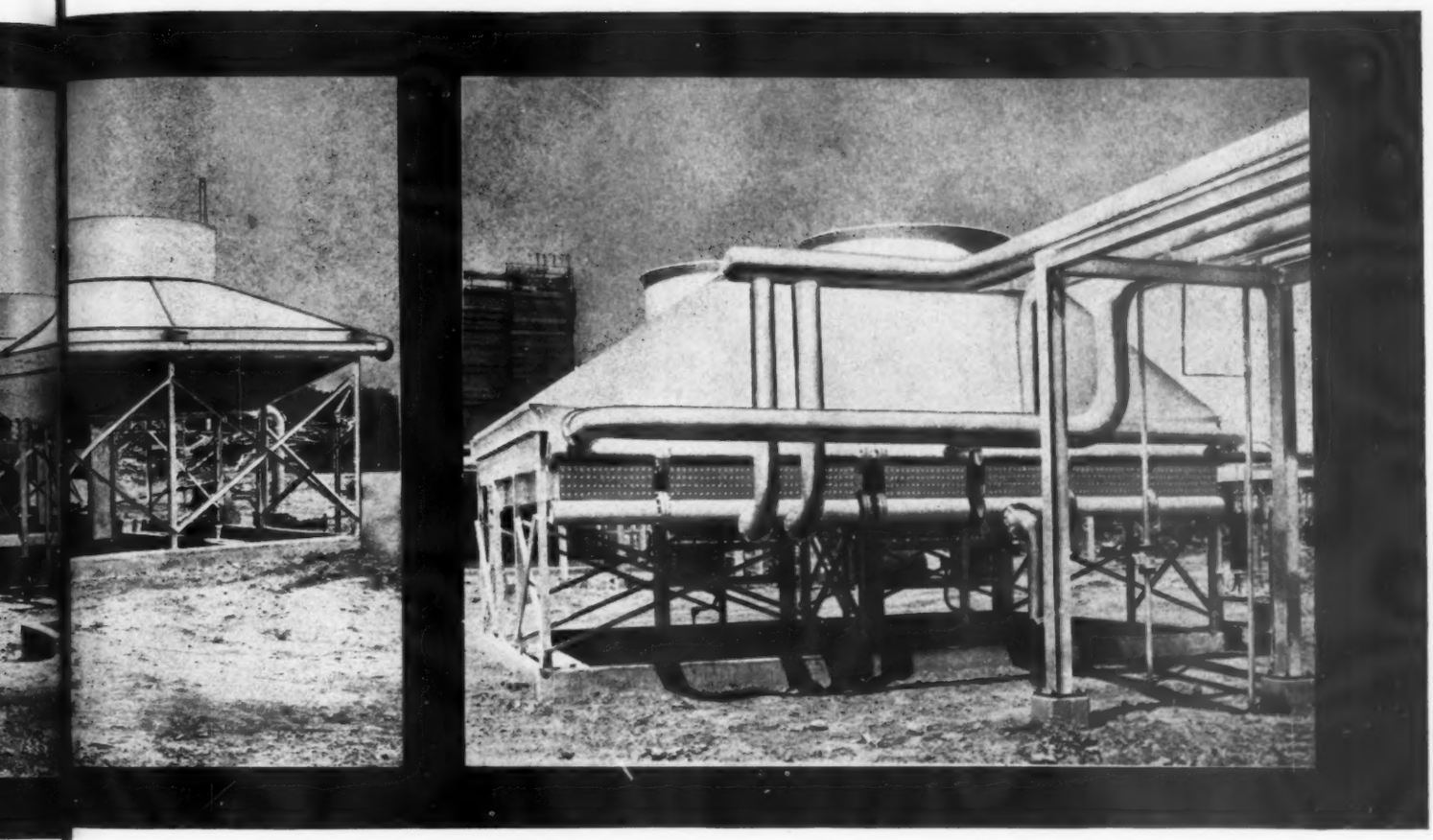
TWO TYPES OF ALCO AIR COOLED HEAT EXCHANGERS. ALCO is in a position to give impartial counsel as to which type of cooling surface—*radiator core* or *fin tube*—to employ, since it manufactures both types.

ELIMINATE THE WATER CYCLE. ALCO Air Cooled Heat Exchangers eliminate the water cycle entirely—dissipate heat directly to the air in one operation. Where water is scarce, or has a high impurity content, this feature is invaluable. Other advantages are:

1. Wind direction does not affect efficiency.
2. Natural draft construction increases efficiency of unit. This reduces power requirements to such an extent that at times this natural draft is sufficient to provide adequate cooling without use of fans.
3. Cooling surfaces are so positioned as to minimize damage by wind-driven sand, rain, or hail.
4. Fans may be driven by any form of power.
5. Induced draft insures uniform distribution of air across cooling surface.

ADVANTAGES OF ALCO DESIGN. Selection of the type of cooling surface to be used should be determined by economics and process requirements. However, where con-

eaxchanger Installation in the World



ditions and requirements permit, use of ALCO Fin Tube Air Cooled Heat Exchangers affords certain important advantages in addition to those listed above. These additional advantages are:

1. Separate surfaces for separate cooling duties can be mounted in the same unit.

2. Header design permits variation of passes to suit process requirements of a given job, thus allowing selection of minimum surface within pressure drop limitations of the process while maintaining maximum velocity required for highest rate of heat transfer.

3. Orifices built into manifold-header design assure uniform distribution to entire cooling surface.

4. Bundle design of ALCO fin tube construction eliminates all air leakage.

FOR FURTHER INFORMATION or engineering counsel write American Locomotive Company, 30 Church Street, New York 8, N. Y. Manufactured and sold in Canada by the Montreal Locomotive Works, Ltd. In the British Empire by Daniel Adamson & Co., Ltd.

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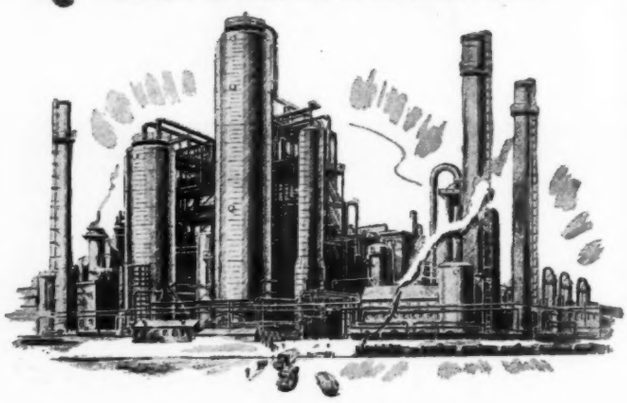
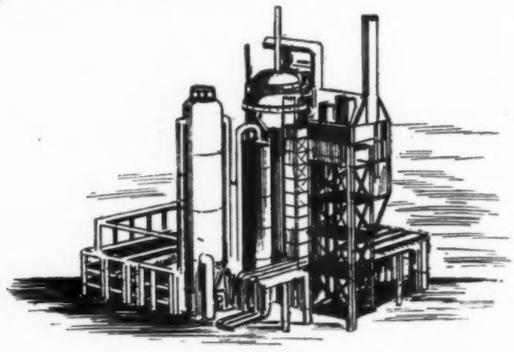
The petroleum industry is a progressive industry dedicated to serve mankind faithfully and well

Q. Which company operates the largest combination crude distillation and Houdry catalytic cracking unit in the United States?

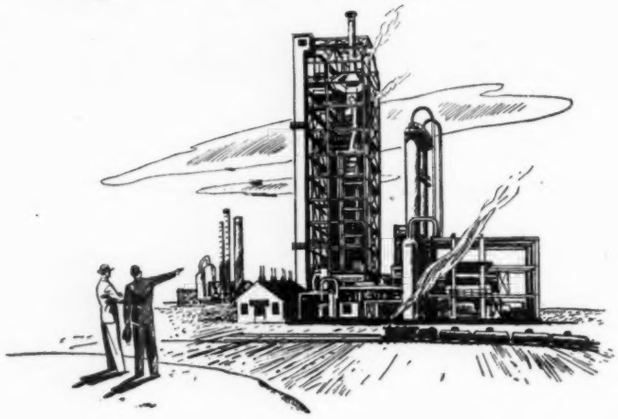


Q. Which company built the first pipe line from the Pennsylvania oil fields to the Atlantic Seaboard?

Q. Which company holds the World's Record—415½ days—for continuous operation of a fluid catalytic cracking unit?



Q. Which company holds the World's Record—240 days—for continuous operation of a Thermofor cat-cracking plant?



Q. Which company is the world's largest refiner and marketer of 100% Pennsylvania Oil?

A.

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IT'S REPUBLIC ELECTRIC WELD LINE PIPE

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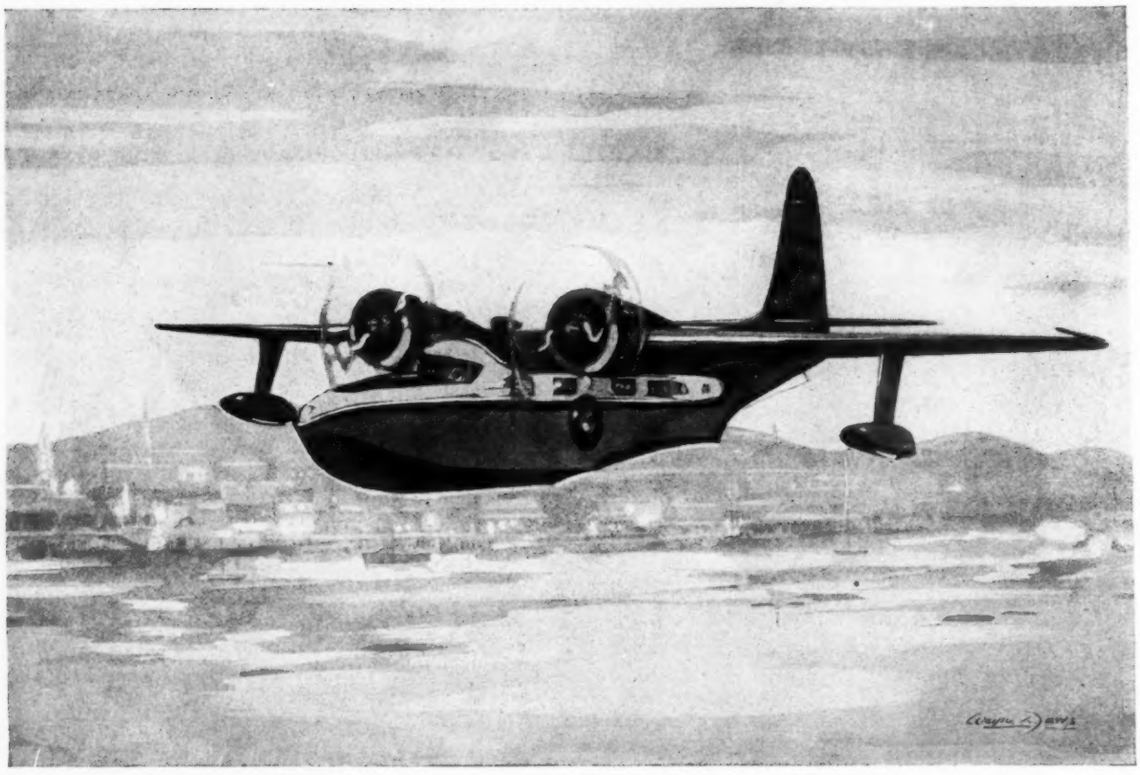

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Many factors influence ultimate earning power of a refinery. But nothing provides a sounder base for favorable statements . . . than proper design of refining facilities.

For example, *quality as well as quantity of yield* are established for years to come on the drawing board.

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And *maintenance,* while controlled by operation, can still be favorably affected by intelligent specification of metallurgical and equipment standards.

Finally, *flexibility*—the ability to follow the supply of raw materials *and* the market for products—must be designed into a refinery unit *before* its construction.

These are not by any means all of the "plus values" that design can contribute to earning power. However, they do point inexorably to the conclusion that . . . for earning power to be at the maximum during the life of processing units . . . "There can be no substitute for the *best* design!"

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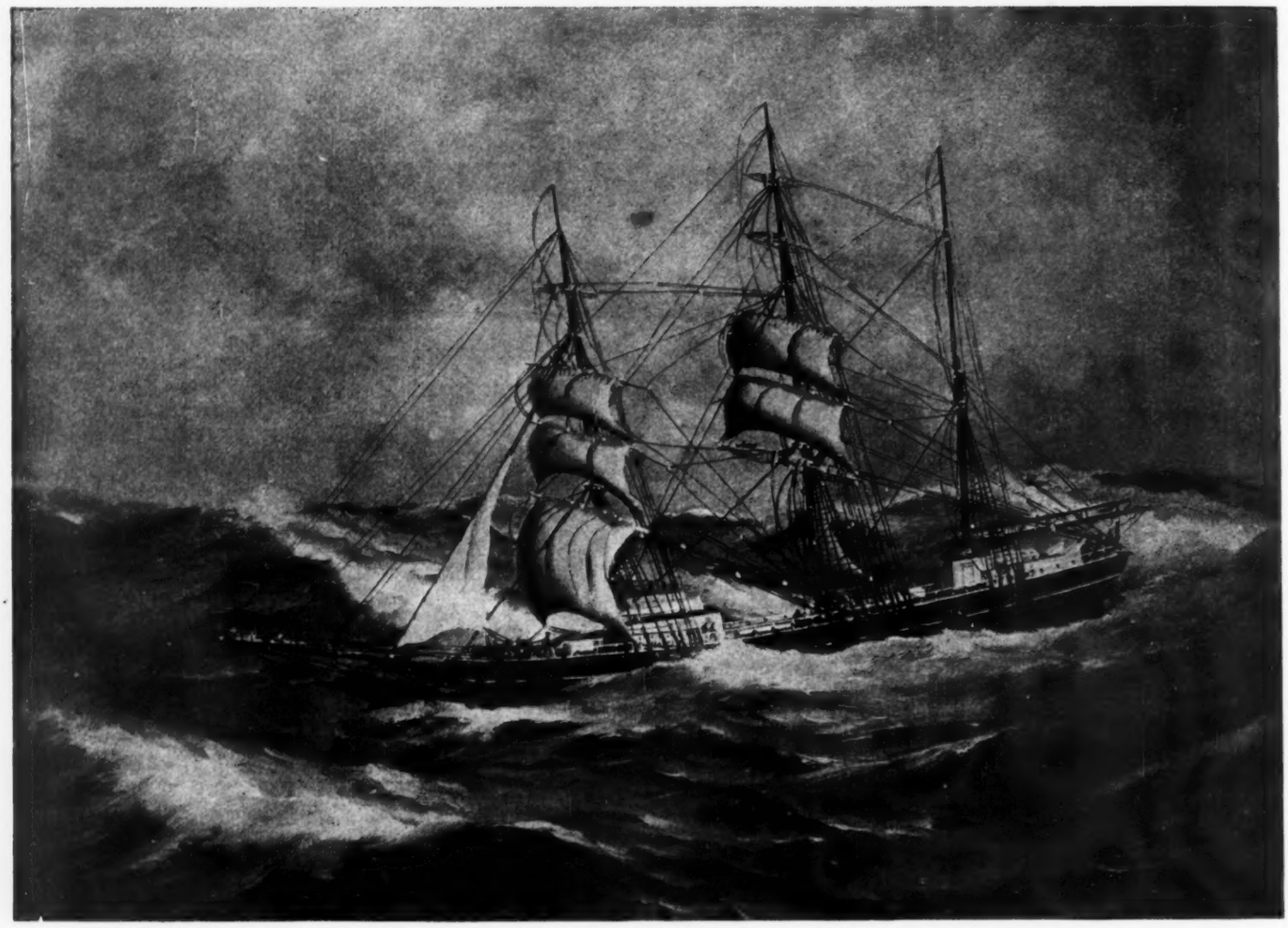

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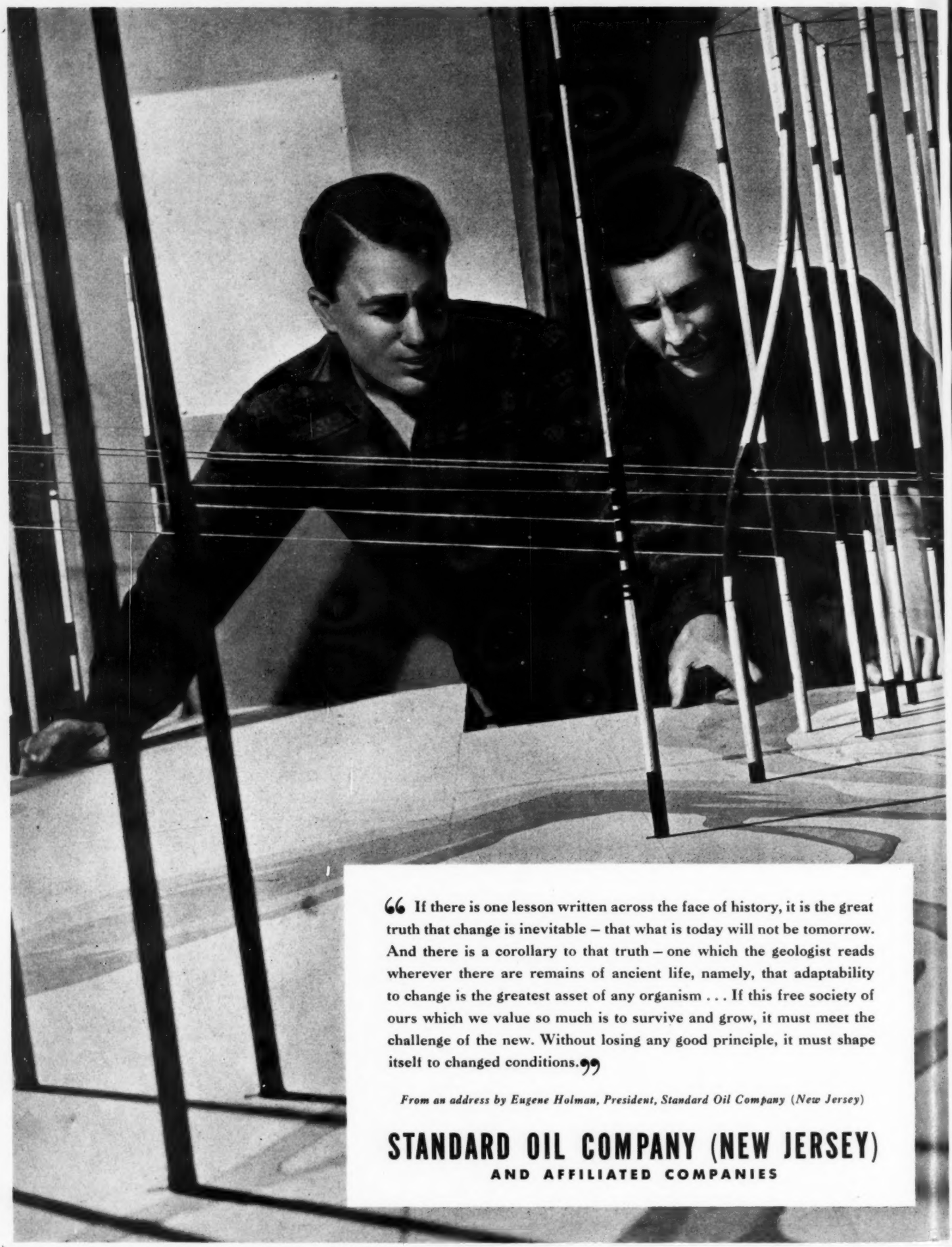

"If there is one lesson written across the face of history, it is the great truth that change is inevitable – that what is today will not be tomorrow. And there is a corollary to that truth – one which the geologist reads wherever there are remains of ancient life, namely, that adaptability to change is the greatest asset of any organism . . . If this free society of ours which we value so much is to survive and grow, it must meet the challenge of the new. Without losing any good principle, it must shape itself to changed conditions."

From an address by Eugene Holman, President, Standard Oil Company (New Jersey)

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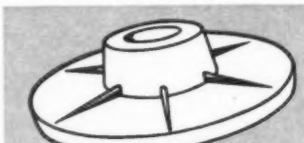

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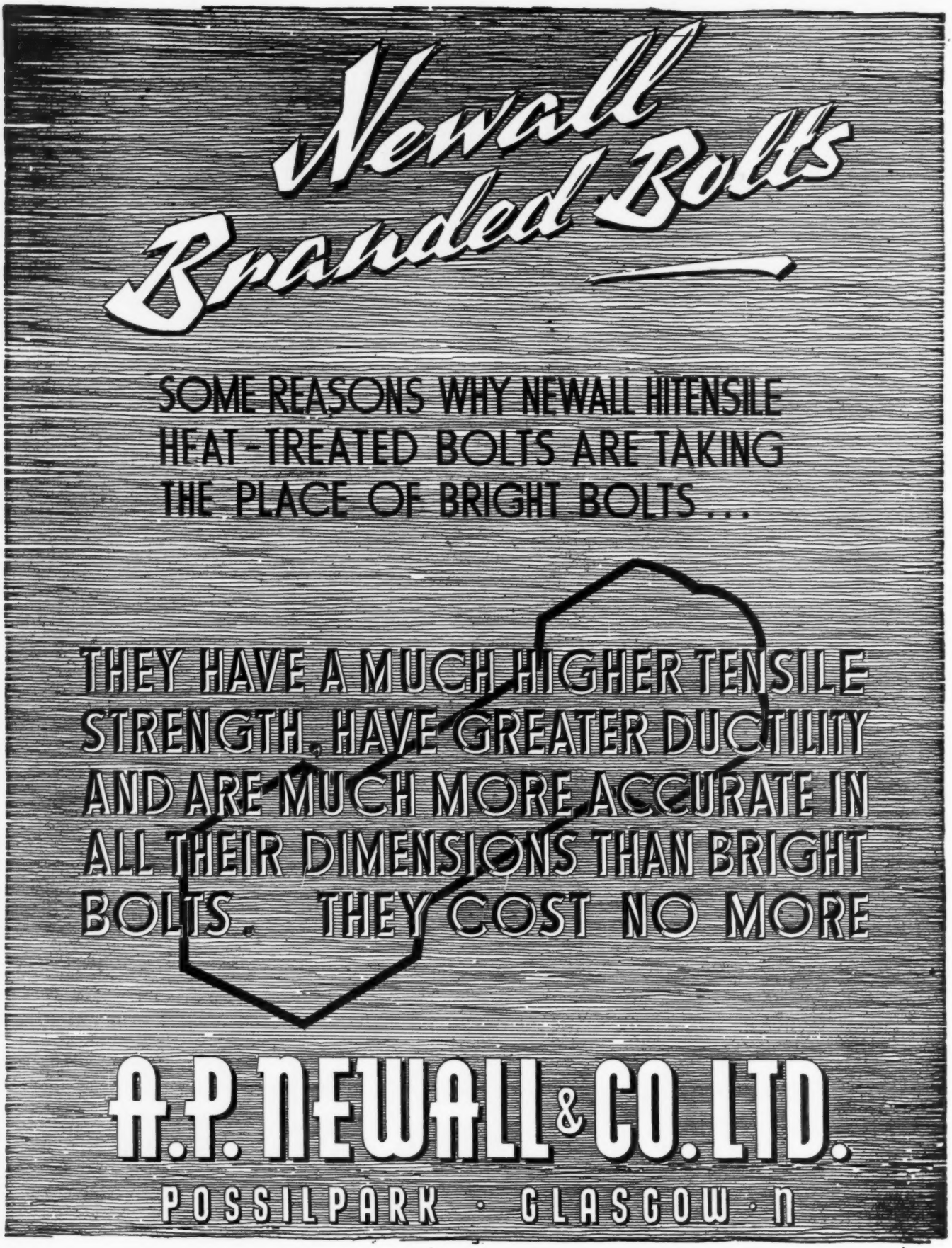
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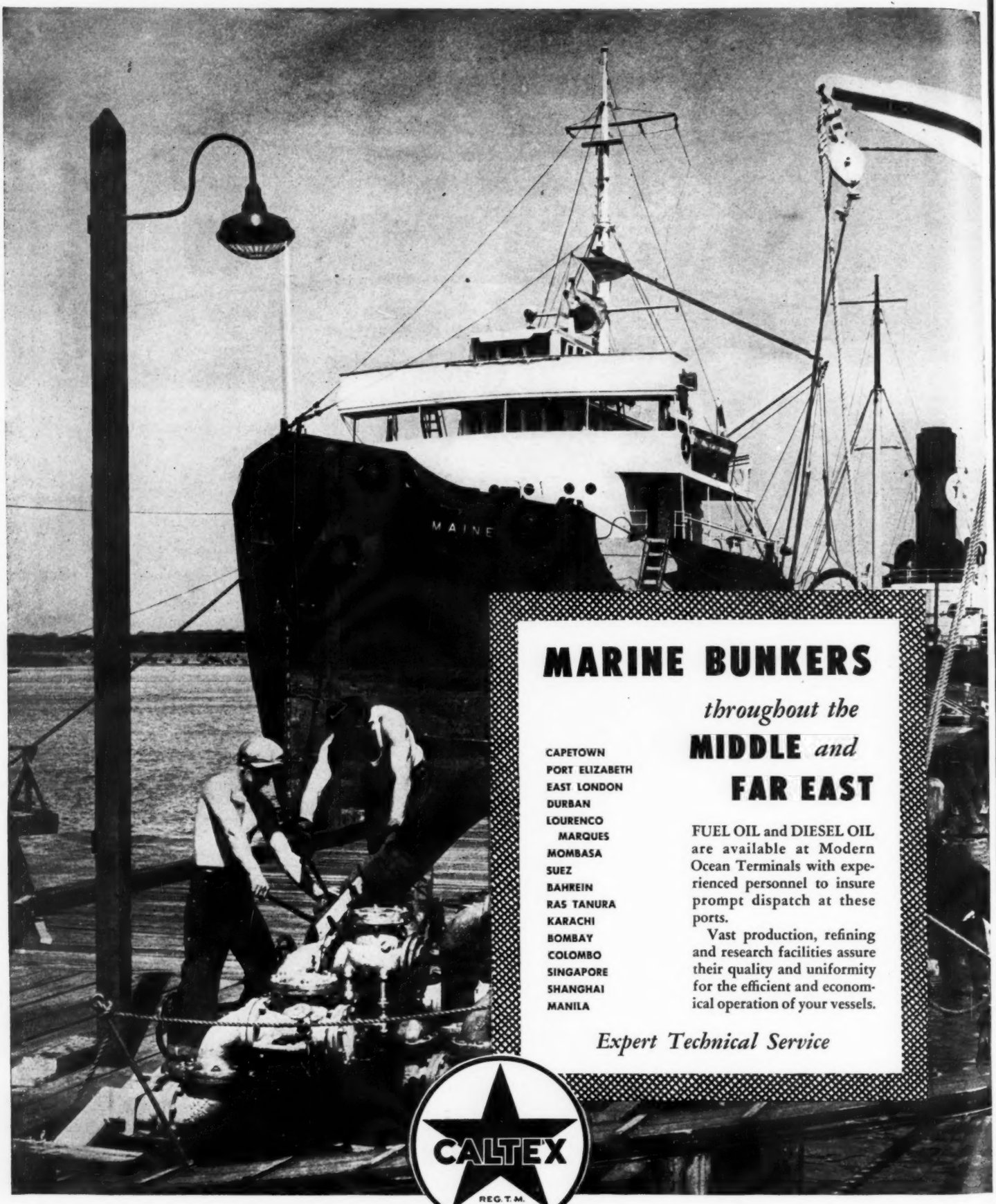

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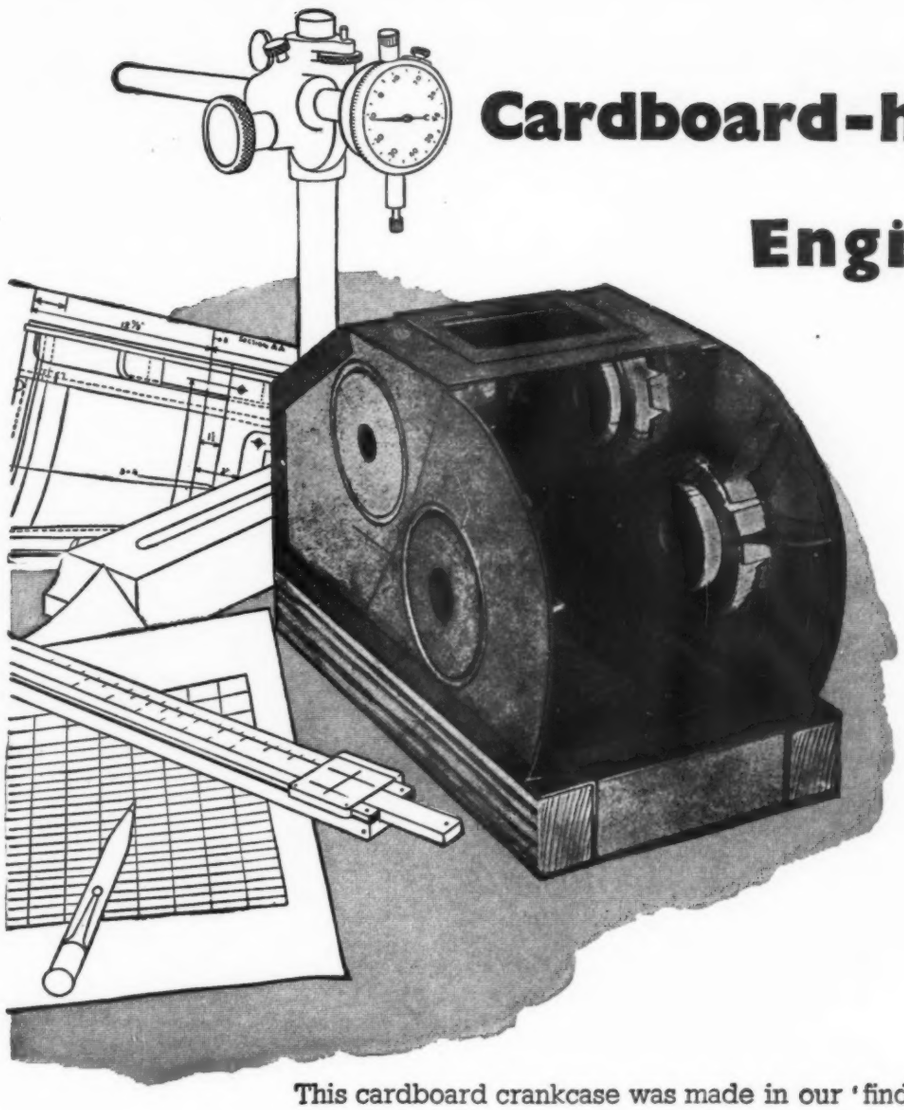

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This cardboard crankcase was made in our 'finding-out' room to test the theory of stressed skin structures in relation to a particular job. We enjoyed ourselves. Our calculations were varied, ingenious and startling—and disconcertingly easy to check with a little glue and more cardboard. Ultimate result—something new was discovered—something to the advantage of our Oil Country Pumps. Was that a triumphant vindication of kindergarten methods with higher mathematics?

OIL COUNTRY,
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RECIPROCATING AND
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ONE RESPONSIBILITY
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Whatever the piping job calls for—anywhere in the refinery—most likely the best item for the purpose can be secured from Crane.

This compressor hookup to fluid catalyst cracking unit, for example, tells the story of how working with the complete Crane line simplifies all piping installations—from design to erection to maintenance. And how the maximum benefits of standardization are assured by this 3-way advantage:

WORLD'S GREATEST SELECTION—from one source of supply—in brass, iron, and steel valves and fittings, in pipe, piping specialties, accessories, and fabricated piping for all applications. Everything for the job—specified from one line—secured on one order to Crane.

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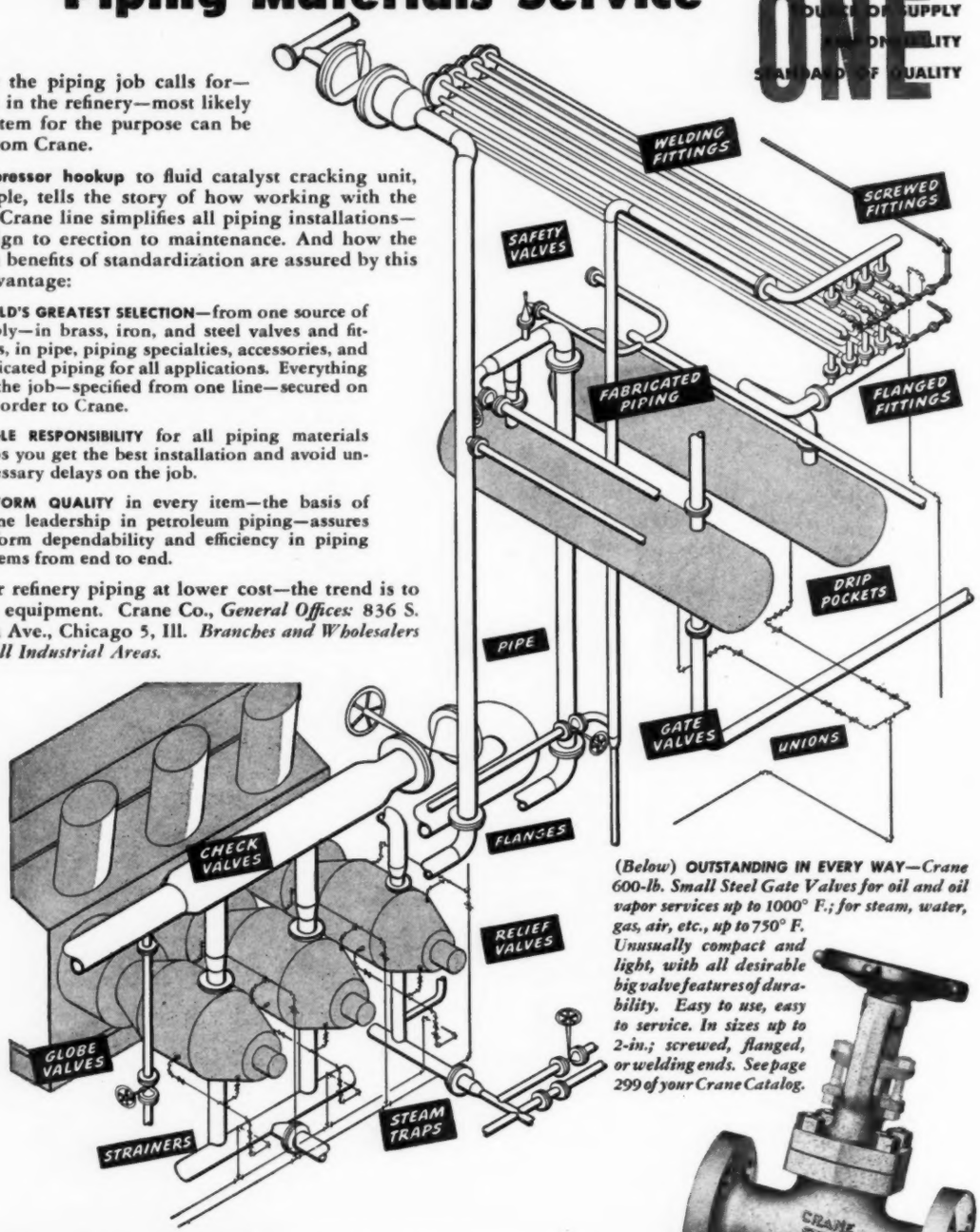
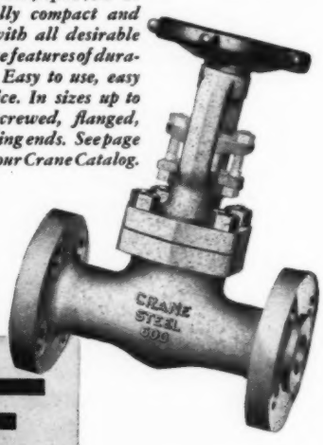


(*Below*) **OUTSTANDING IN EVERY WAY**—*Crane 600-lb. Small Steel Gate Valves for oil and oil vapor services up to 1000° F.; for steam, water, gas, air, etc., up to 750° F. Unusually compact and light, with all desirable big valve features of durability. Easy to use, easy to service. In sizes up to 2-in.; screwed, flanged, or welding ends. See page 299 of your Crane Catalog.*



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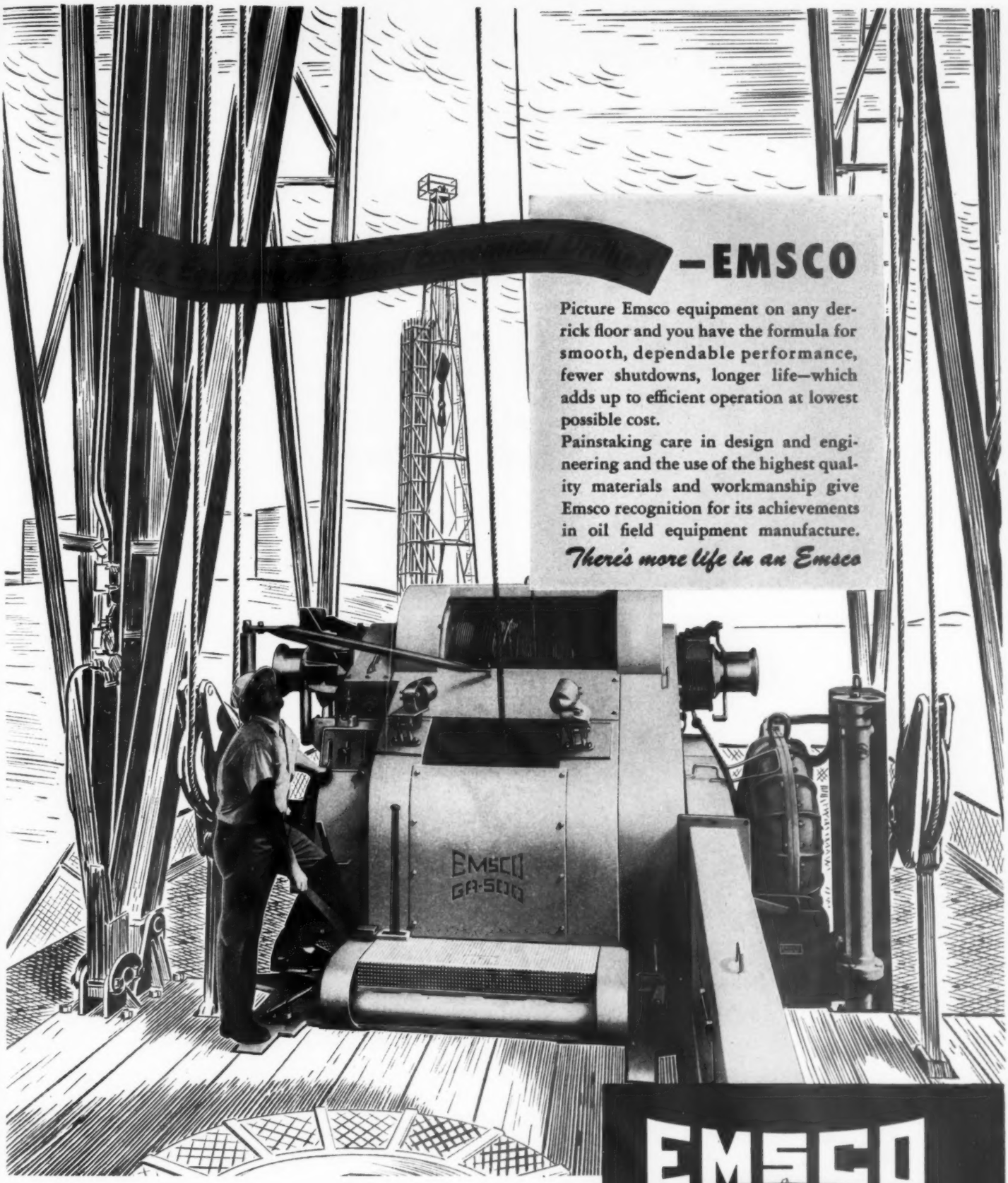

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Youngstown to WEST TEXAS

WEST Texas is headed for greater fame as the oil country of tomorrow. Recent exploratory drilling has revealed tremendous petroleum deposits and last year, for example, West Texas added over 200 million barrels to her proven reserves.

1946 sees the country's biggest drilling program in progress in West Texas--nearly 8½ million feet projected. This has not been a deep-well area, but new depths are being reached--at below 15,000 feet--with a producing depth record of 11,422 feet, sixth deepest in the world.

Twelve West Texas fields yield more than 10,000 barrels a day... six exceed 25,000 barrels each. With adequate pipe line facilities West Texas sweet crude production, now around 76,000 barrels daily, could be readily doubled.

West Texas has used thousands of tons of Youngstown pipe since oil was found there in 1922. For future operations, too, there will be plenty of Youngstown quality pipe available, backed by the same dependable service. Here, as in every other Texas district--in fact, in every other oil-producing region--oil men know that orange bands on oil country tubular goods are the sign of good service and dependable performance under all conditions encountered by oil producers.

Locations circled indicate Continental Supply Company stores.

Identify Youngstown Oil Country Tubular Goods by the orange band or bands.

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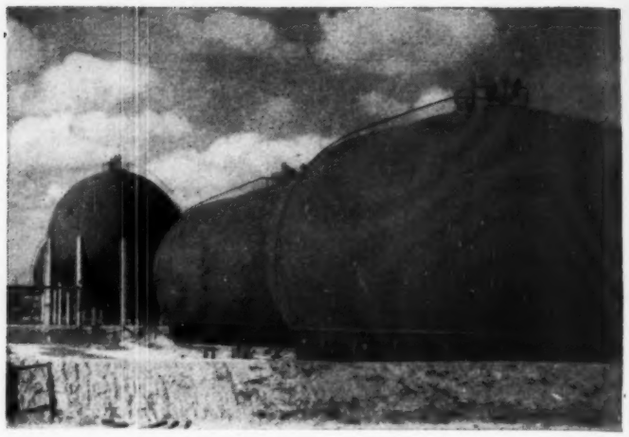
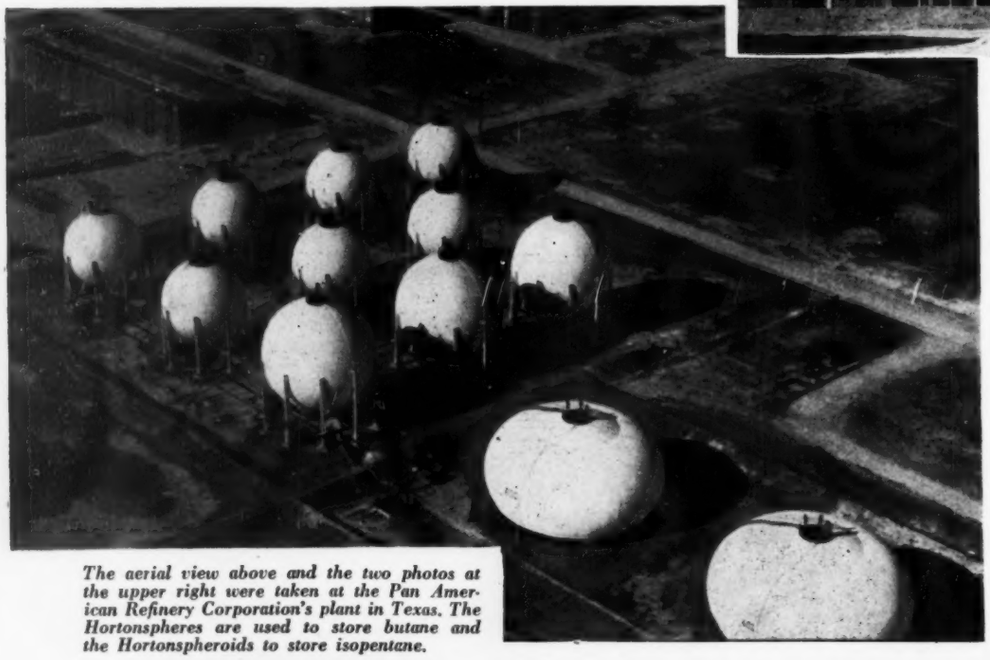
Another Refinery depends on HORTONSPHERES and HORTONSPHEROIDS



—to store volatile products and protect them against evaporation losses and fire hazard

It's the Pan American Refining Corporation's plant at Texas City, Texas — another of the nation's great refineries — that has installed Hortonspheres and Hortonspheroids. For storing hydrocarbons that range in volatility from motor gasoline to natural gasoline use the Hortonspheroid. For storing highly volatile liquids and gases, use the Hortonsphere. These two types of pressure storage tanks can help refineries accomplish two important goals . . . *increase plant throughput and reduce production costs!*



The aerial view above and the two photos at the upper right were taken at the Pan American Refinery Corporation's plant in Texas. The Hortonspheres are used to store butane and the Hortonspheroids to store isopentane.

HORTONSPHERES are built in standard capacities for pressures as high as 50 lbs. per sq. in. up to 65 ft. in diam.; 75 lbs. up to 51 ft. in diam.; 100 lbs. up to 40 ft. 6 in. in diam.; 125 lbs. up to 30 ft. 3 in. in diam.; and 150 lbs. up to 28 ft. in diam.

HORTONSPHEROIDS (Smooth type) are built in capacities of 2,500 to 40,000 bbls. for pressures from 2½ to 30 lbs. per sq. in. Noded type Hortonspheroids are built in capacities of 20,000 to 120,000 bbls. for pressures from 5 to 20 lbs. per sq. in.

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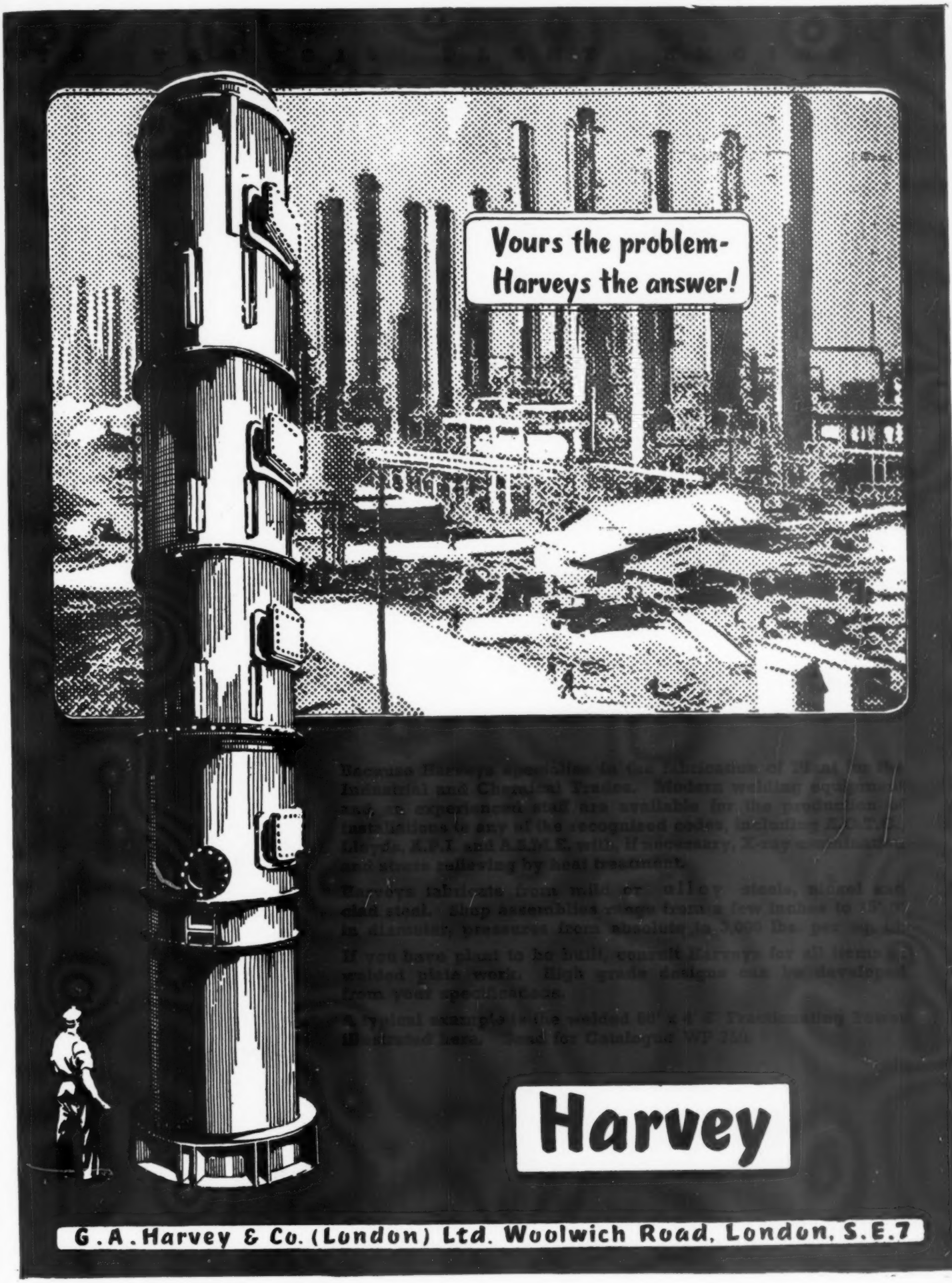
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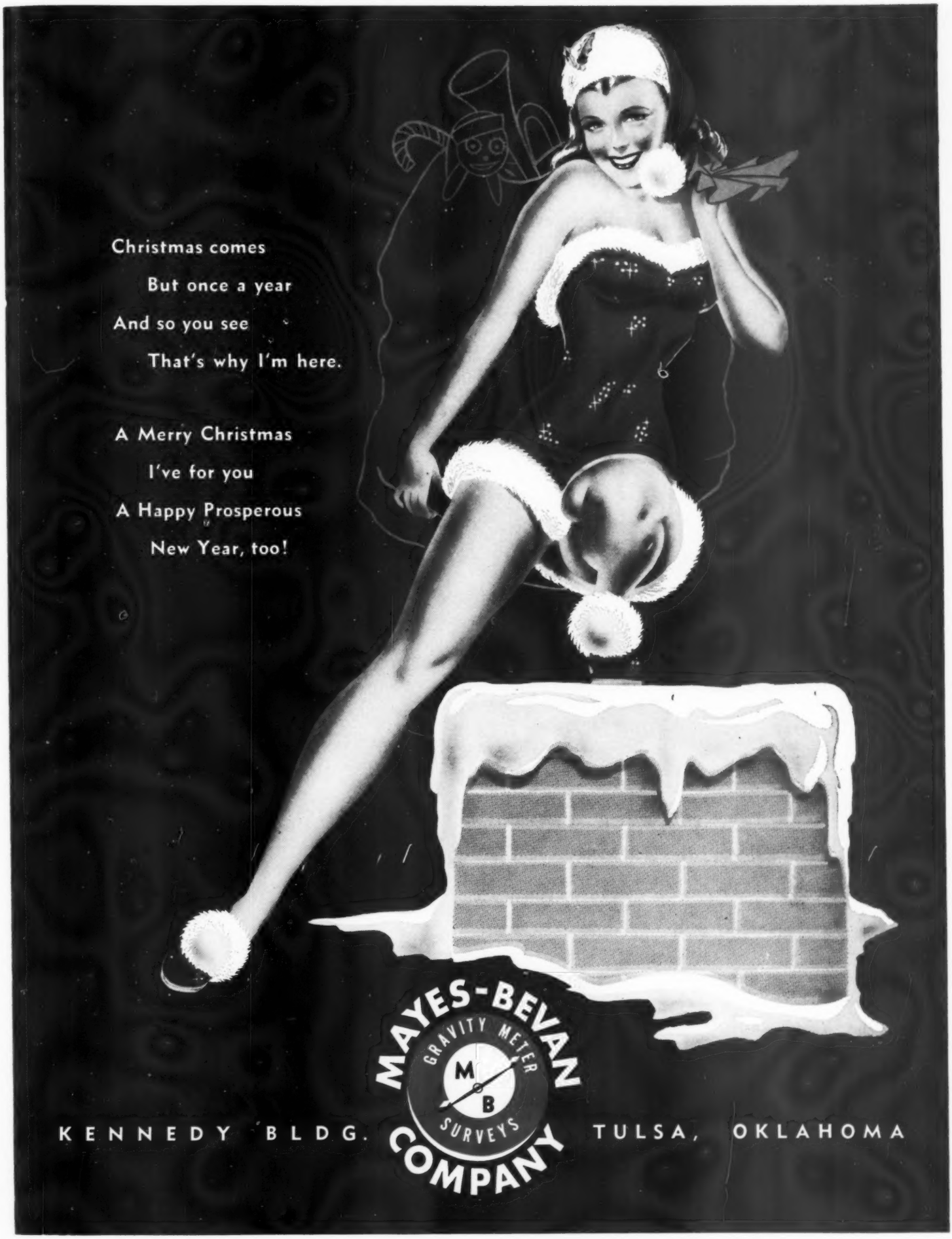
CHEMICO *plants are profitable investments*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But once a year
And so you see
That's why I'm here.
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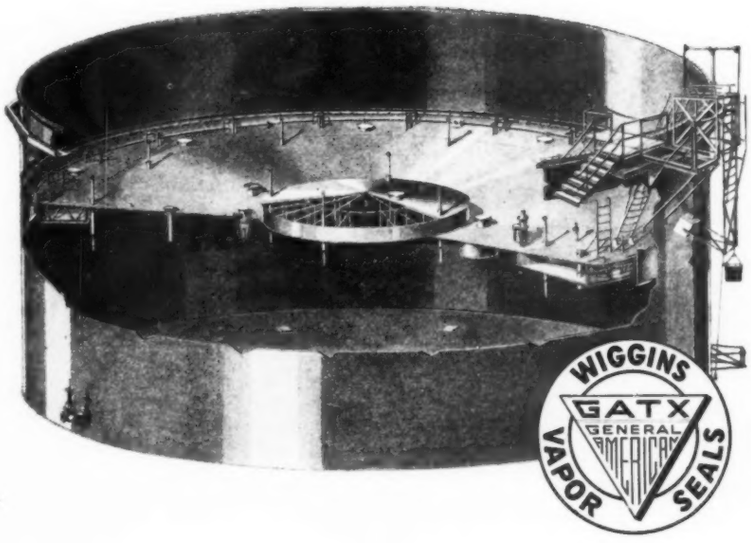

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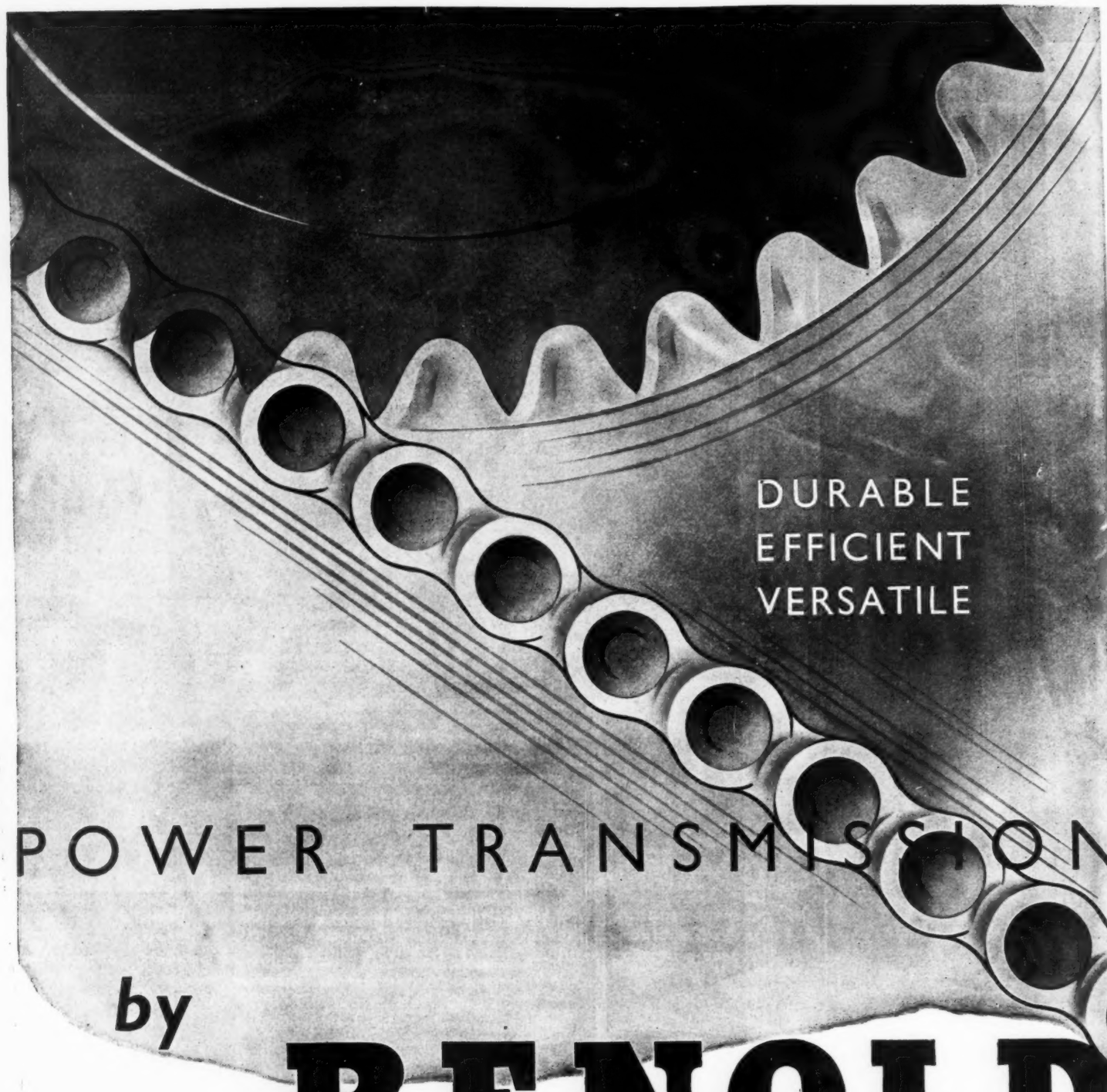

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The mast raising is entirely automatic, being powered through a standard power take-off from truck transmission. A simple locking device retains the mast in the operating position.

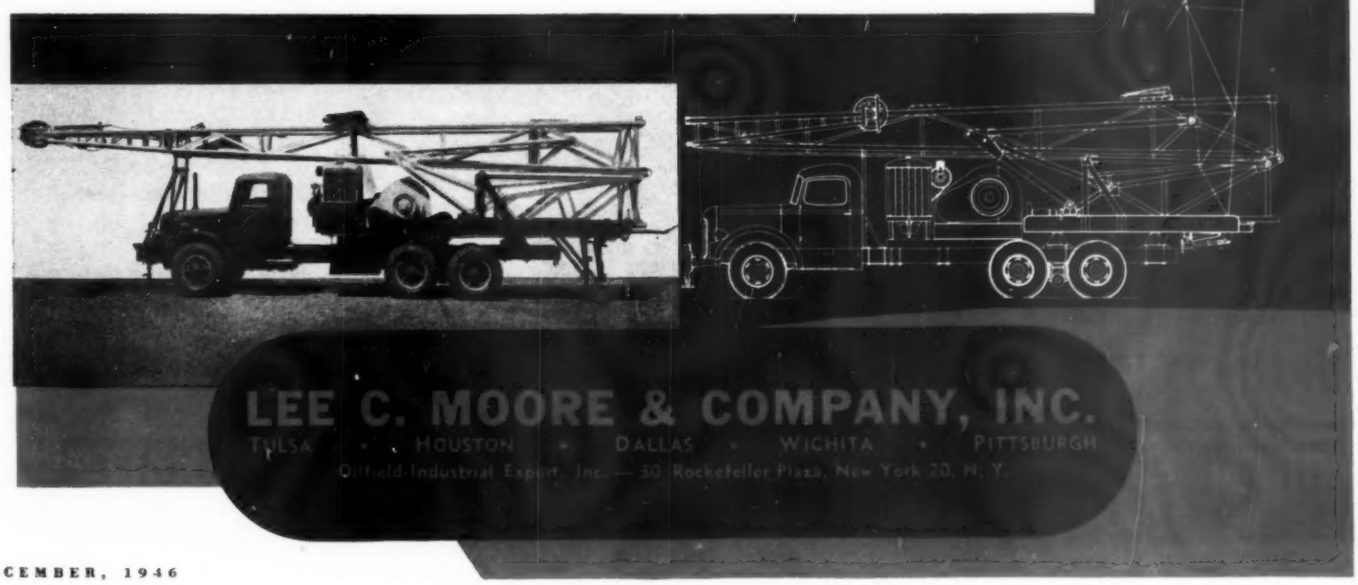
Alloy steel square tubular legs and other tubular construction insures maximum strength and rigidity with minimum weight. All pivot points in the folding mast are equipped with roller bearings to insure lightness and long life.

Additional savings of time and cost reductions are realized by the complete elimination of ground guys and earth anchors. Built-in guy lines extending from front end of truck to top of mast are used only occasionally for extremely heavy pulls.

The mast is complete with rod hanger bracket, rod platform and folding tubing platform which can be attached to suit range I doubles or range II singles. Rods are pulled and hung in doubles. Hook load capacity is based on 6,000 ft. of rods being hung in the mast.

The standard 63 ft. Automatic Well Servicing Mast has a capacity of 66,000 lbs. hook load with three lines to tubing block: front legs of 4" square X-4130 steel tubing, 2-24" manganese steel roller bearing crown sheaves grooved for 7/8" wire line, mounted on 4" diameter hardened and ground shaft. Mast complete with rod platform and tubing platform with non-slip steel flooring; tubing platform to accommodate 100 stands of 2½" tubing with positions provided to rack range I doubles or range II singles. Over-the-road dimensions 12'-3" high and 35 ft. long; with Unit Rig U-24 hoist with power, or with Cardwell Model H hoist with power, all mounted on International Model K-11-F truck.

Same unit as above with Unit Rig U-24 hoist with power, or with Cardwell Model H hoist with power, all mounted on Mack LFSW truck.



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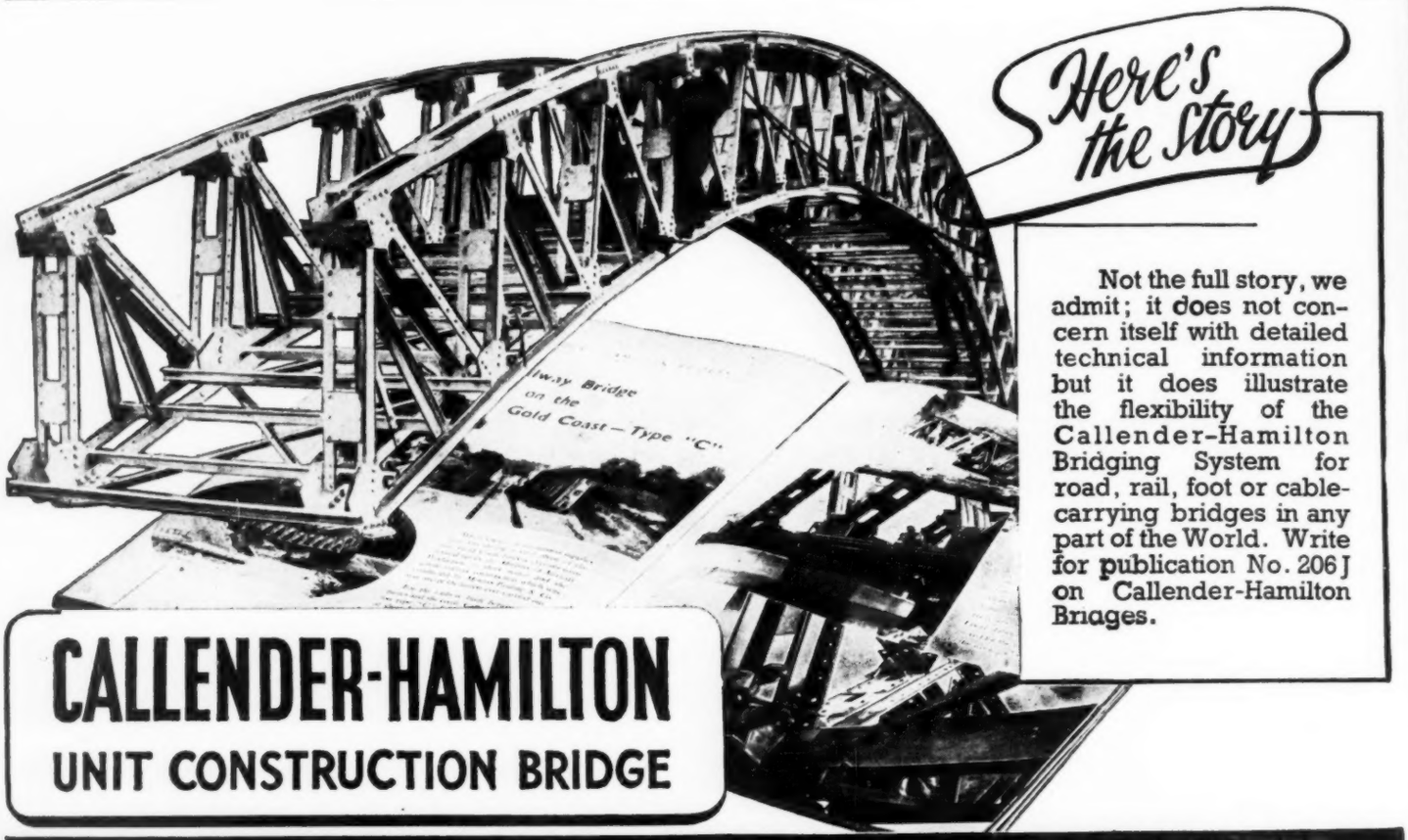
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Provides intimate lapped fit.

2 **SIMPLE ROTARY ACTION**
No seat separation; no deposits can intrude.

3 **RESILIENT PLUG SEATING**
Prevents binding; permits lubricant distribution.

4 **PRESSURE LUBRICATION**
Positive injection of lubricant to seating surfaces.

5 **"SEALDPORT" PRINCIPLE**
Full lubricant seal around each port.

6 **HYDRAULIC LUBRICANT JACKING**
Insures operation; permits effective lubrication.

7 **SEPARATE THREADED STEM**
Carries pressure-thrust without binding.

8 **INJECTION TYPE PACKING**
Renewable without disturbing valve position or line pressure.

9 **CORROSION-RESISTANT**
Lubricant film protects vital seating surfaces.

10 **STRAIGHT-THROUGH FLOW**
No changes in direction or turbulence-producing cavities.

11 **RUGGED DESIGN**
Compact construction, heavy sections, simplicity, insure durability.

12 **QUARTER TURN**
Quick and positive action.

13 **EROSION-RESISTANT**
No vital parts exposed to line flow.

14 **ROTARY OPERATION**
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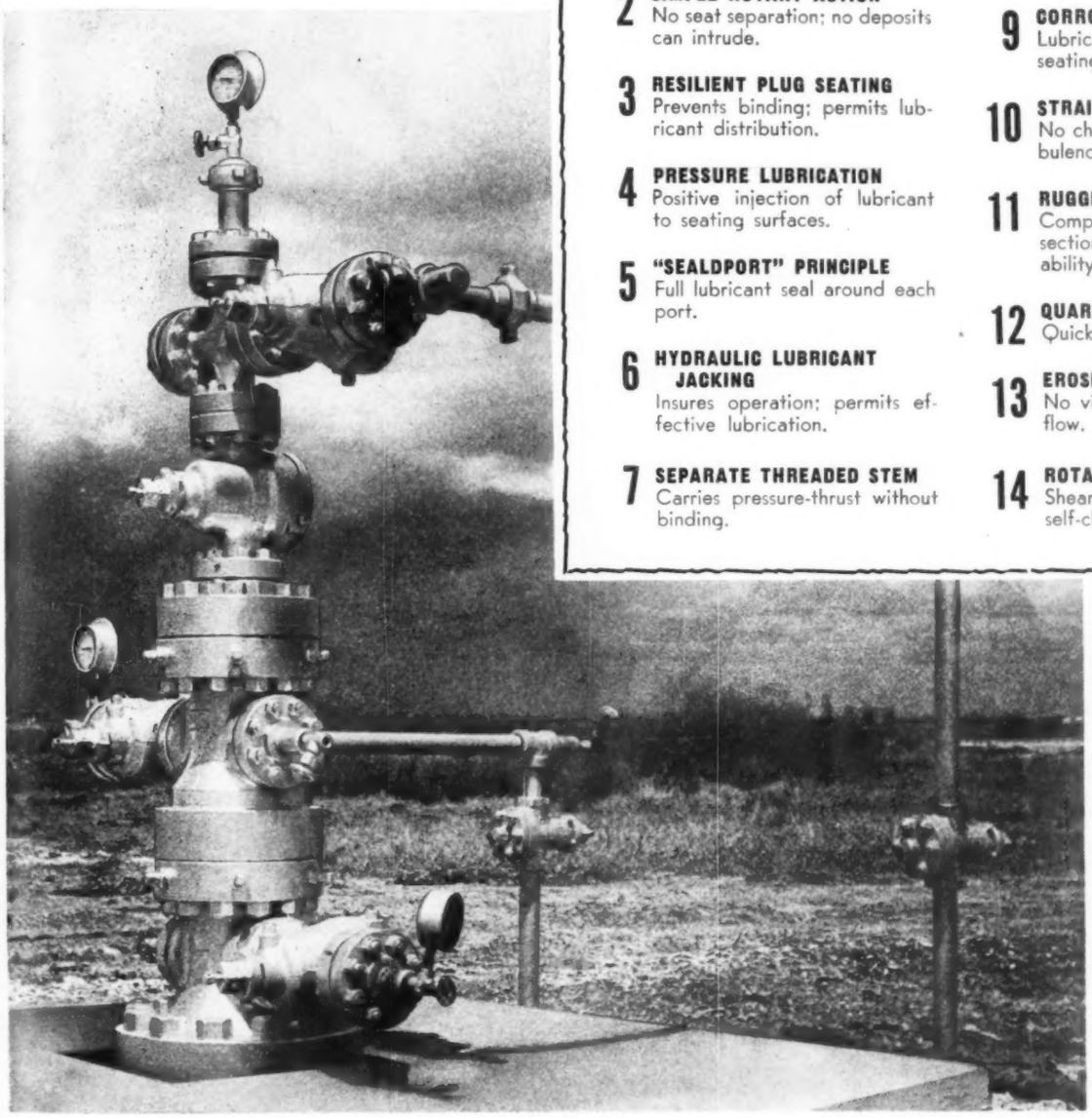

High pressure Hypreseal valves on a Christmas tree.

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An Audience with Saudi Arabia's *Equipment Buyers*

Look closely at these native workers and you'll see the changing destiny of the Middle East. Formerly tribesmen, hunters of the plains, today these men are employees of an American oil company, insulating refinery steam lines under the blazing skies of Saudi Arabia. Round their heads are the turbans of an ancient race—but their hands are trained to use American-made tools and machinery. Theirs is the job of drilling, refining and transporting oil to power the wheels of modern industry.

● Vast amounts of heavy machinery and petroleum equipment must be shipped to Saudi Arabia. Most of it will come from America. Men who are now purchasing this equipment, the men who direct the oil development of Saudi Arabia, are readers of WORLD PETROLEUM. They are intensely interested in global oil changes, authoritatively presented in the editorial columns of WORLD PETROLEUM, and are influenced by its advertising pages. It is the only publication covering *all* the key purchasing personnel wherever oil is produced. Let *your* oil equipment message reach this influential audience through WORLD PETROLEUM.

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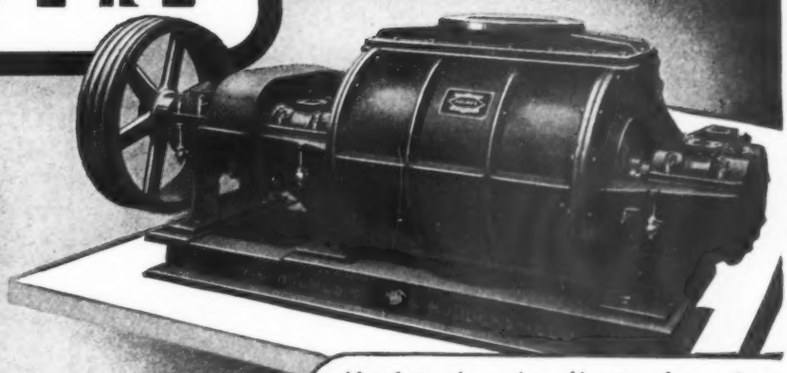

These machines deliver a positive, reliable and oil-free supply of air, economically and efficiently. Absence of internal contact ensures long life, low maintenance costs and continuous operation over long periods.

It is also extensively used for Gas Exhausting or Boosting and over 1,400 machines have been supplied for these purposes.

Manufactured under Licence from Roots-Connersville Blower Corporation of America, for Great Britain, the Dominions and Colonies

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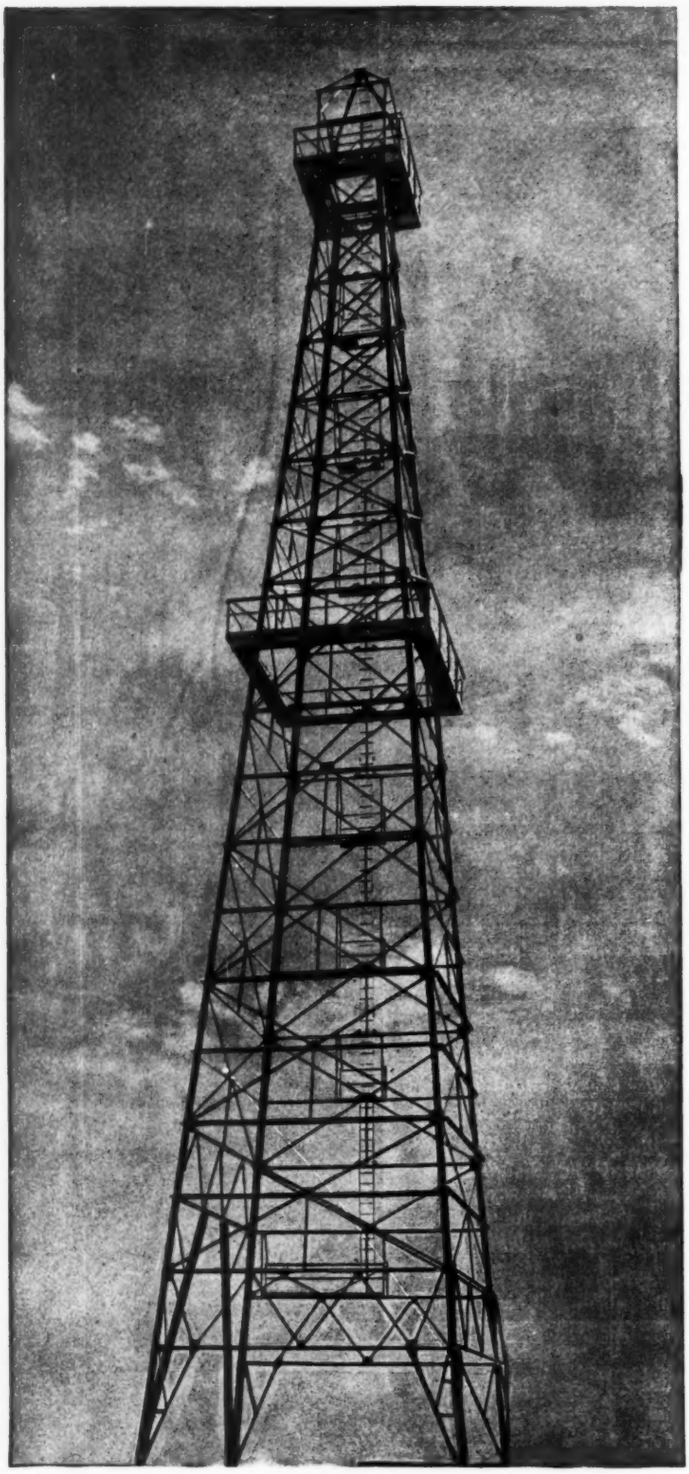

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ADVERTISERS' INDEX

Airwork, Ltd. 4
American Locomotive Co. 10-11

Baroid Sales Div. 21
British Insulated Callenders Cables, Ltd. 86
British Thomson Houston Co., Ltd. 6
Brown & Root, Inc. ..... Inside Front Cover
Butterfield Ltd., W. P. 7

California Texas Oil Co. 24
Chemical Construction Corp. 34
Chicago Bridge & Iron Co. 30
Clayton Sons & Co., Ltd. 78
Crane Co. 26

Decca Navigator Co., Ltd. 69

Edmundson Towing Co. 78
Emsco Derrick & Equipment Co. 27
Evans & Sons, Joseph 19

Ferguson & Timpson, Ltd. 80

Gaso Pump & Burner Mfg. Co. 71
General American Transportation Co., Wiggins Roof Div. 81
General Chemical Corp. 75
Great Western Railway 74
Grumman Aircraft Engineering Corp. 14

Harshaw Chemical Co. 74
Harvey & Co., Ltd., G. A. 31
Hayward-Tyler & Co., Ltd. 25
Holmes Ltd., W. C. 91
Houdry Process Corp. 38
Hughes Tool Co. ..... Inside Back Cover
International Harvester Co. 9

Kellogg Co., M. W. 15
Klinger Ltd., Richard 79

Ladish Drop Forge Co. ..... Facing Page 16
London & Midland Steel Scaffolding Co., Ltd. 32

Mayes-Bevan Co. 35
McKee & Co., Arthur G. 5
Mechans, Ltd. 90
Mitchell Engineering Co., Ltd. 92
Moore & Co., Lee C. 85
Murray & Tregurtha, Inc. 33

Negretti & Zambra, Ltd. 86
Newall & Co., Ltd., A. P. 22
Nordstrom Valve Div. 87
North American Geophysical Co. 74

Oil Base, Inc. 77
Oxley Engineering Co., Ltd. 91

Patterson-Ballagh Division, Byron Jackson Co. 23
Petroleum Rectifying Co. 8
Powell Co., Wm. 2

Quasi-Arc Co., Ltd. 73

Renold & Coventry Chain Co., Ltd. 84
Republic Steel Corp. 13

Sharples Corp., The 82-83
Shell Oil Co., Inc. 18
Socony-Vacuum Oil Co. 28
Sperry Sun Well Surveying Co. 78
Standard Oil Co. (N. J.) 20
Standard Vacuum Oil Co. 16
Stewarts & Lloyds, Ltd. 36
Stone & Webster Engineering Corp. 17

Tide Water Associated Oil Co. 12
Tube Turns, Inc. 1

United Steel Companies, Ltd. ..... Facing Page 17

Vogt Machine Co., Henry 3

Weir Ltd., G. & J. 89
Whessoe, Ltd. 76
Wyatt Metal & Boiler Works ..... Back Cover

Yorkshire Copper Works, Ltd. 89
Youngstown Sheet & Tube Co. 29

Zink, John 78

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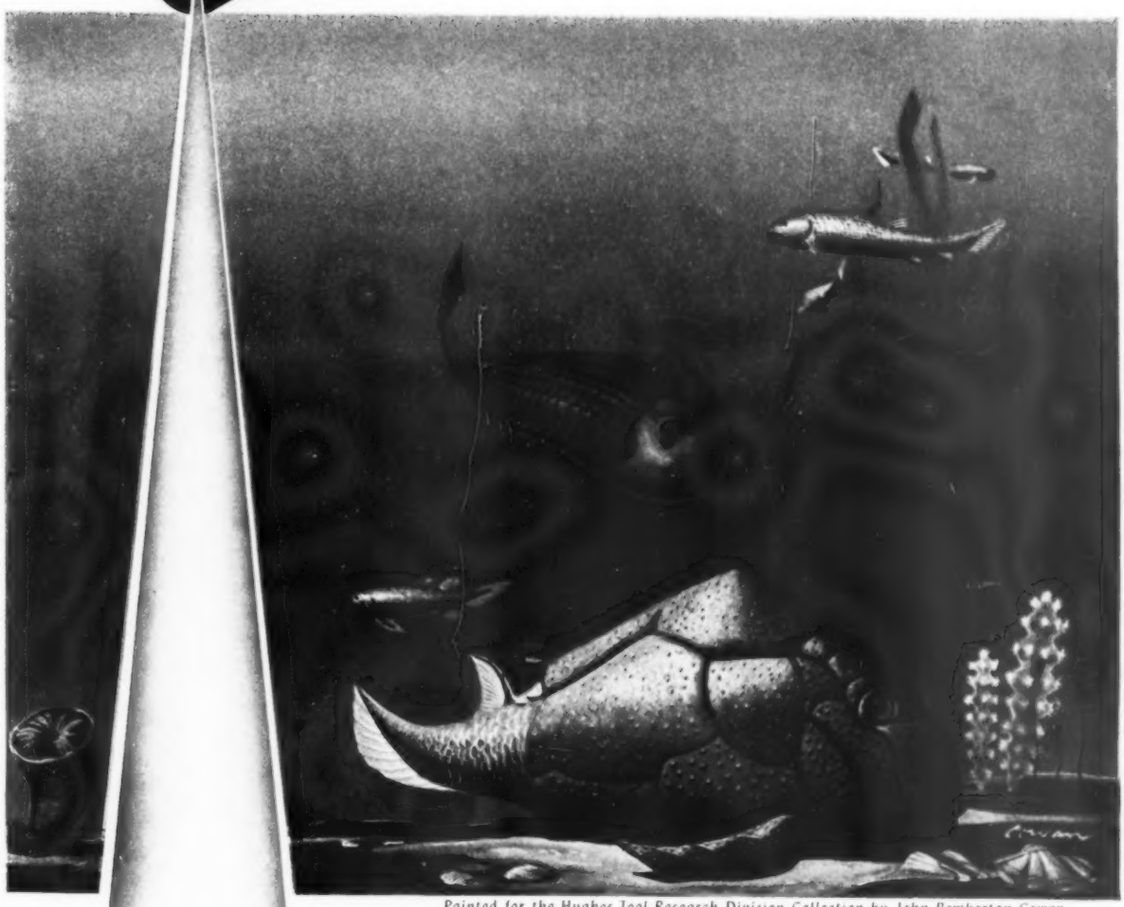

Painted for the Hughes Tool Research Division Collection by John Pemberton Cowan

The DEVONIAN PERIOD was marked by the evolution of animal life from the invertebrate (shell) to the vertebrate (backbone). Shown above are Devonian Ostracoderms in the foreground and Fishes in the background.*

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